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PENNSYLVANIA
GOVERNOR'S CONFERENCE
ON

PNEUMOCONIOSIS
(ANTHRACO-SILICOSIS)

HARRISBURG

NOVEMBER 30, DECEMBER 1, 2, 1964

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF HEALTH
DEPARTMENT OF LABOR & INDUSTRY
DEPARTMENT OF MINES & MINERAL INDUSTRIES


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PENNSYLVANIA GOVERNOR'S CONFERENCE ON PNEUMOCONIOSIS
(Anthraco-silicosis)

FOREWORD

This Conference was called by Governor William W. Scranton.

The purpose of the Conference was to review the pneumoconiosis problem of Pennsylvania coal miners, and to consider and propose recommendations for prevention, diagnosis and compensation of the disease.

Fifty-six speakers from industry, labor, medicine, law and government presented their views in two general and five special sessions. The special session chairmen summarized the presentations at the end of the conference.

The presentations and the summaries are presented in this volume as submitted by the speakers and session chairmen, in order of their appearance at the conference.

Jan Lieben, M.D.
General Program Chairman

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OPENING REMARKS

C. L. Wilbar, Jr., M.D., Secretary
Department of Health
Commonwealth of Pennsylvania

Governor Scranton, Ladies and Gentlemen, welcome to the Governor's Conference on Pneumoconiosis.

Pneumoconiosis is a very major health problem in Pennsylvania. Anthraco-silicosis is the cause of most of the pneumoconiosis in this State.

Since difficulty occurs from time to time, even in some printed articles, as to the meaning of certain terms to be used in this Conference, I shall make an attempt at the outset to clarify terminology. The term "pneumoconiosis" comes from two Greek words - "pneumon" meaning lung and "konis" meaning dust. Thus, pneumoconiosis is a disease condition caused by dust in the lung. The Greek word for coal is "anthrax". Thus a disease condition caused by coal in the lung is anthracosis. If the coal dust has silica in it, the disease condition is "anthraco-silicosis".

Approximately 900 persons die in Pennsylvania each year with pneumoconiosis as the primary cause of death. In almost an equal number, pneumoconiosis is given as a major contributing factor. There is, for instance, a high incidence of tuberculosis in our hard coal mining areas because of lowered resistance to this disease on the part of those with anthraco-silicosis; and tuberculosis is a disease transmittible to those nearby such as wives and children. Compare 938 deaths from pneumoconiosis in Pennsylvania in 1963 to 738 deaths from tuberculosis, or 790 deaths from ulcers, or 367 deaths from gall bladder diseases, or 126 deaths from appendicitis. The number of deaths caused by pneumoconiosis has been increasing yearly. For each death during the year, there are approximately 15 cases of pneumoconiosis.

It is a Health Department's function to do everything it possibly can to prevent a malady from occurring or at least from causing disability and death. We have conquered most of the communicable diseases in the United States during this century--diptheria, plague, cholera, malaria and lately poliomyelitis. In 1963, Pennsylvania had 110 cases of polio out of 448 in the entire nation. This year, up to the present time, there have been no polio cases reported in our State. And the reported new cases of tuberculosis have declined.

We must now turn our preventive know-how to the chronic diseases. Here we have no immunization measures, but there are known methods, discovered in this country and in other countries, which if applied could dramatically reduce the incidences and severity of most of these chronic diseases, including anthraco-silicosis.

I do not refer to stopping the deep mining of coal. It is largely a matter of controlling the inhalation of dust. There seems to be reasonable certainty that there is a definite quantitative relationship between dust inhalation and the development of disease. Industrial dust control programs of reasonable success have been in effect for some years in Great Britain, Canada and North Carolina and we will be fortunate to hear something about these later this afternoon.

All the answers are not known. There are differences in incidence of anthraco-silicosis in different mines, even in the same region. Size and type of dust particles, as well as mining conditions and individuals' resistance are significant variables. Further studies, such as the Pennsylvania Department of Health and the one the United States Public Health Service have been making, are needed--using lung x-rays, lung function tests, dust counts and analyses. However, there is much known that we can apply to reduce the great toll of lives, of ill-health, of unhappiness and of great economic loss to individuals, to industry and to the Commonwealth which are now occurring.

Realizing what a major problem for Pennsylvania's health and economy anthraco-silicosis is, Governor Scranton has called this conference of leaders among industry, labor and science to move forward with plans and action to conquer this scourge. Because of his tremendous interest and knowledge concerning this subject, Governor Scranton is personally present to state his feelings on the subject.

Fellow Pennsylvanians – honored guests:

I want you to know how much I appreciate the time you have taken from your busy schedules to come to Harrisburg to discuss a problem which is of major importance to all of us and directly or indirectly to every citizen of this Commonwealth.

As Governor I am speaking to you as a long-time resident of our coal region. There is no question in anybody's mind today that we have a major problem in the disabling occupational disease peculiar to miners. This is most serious in our anthracite region and to a somewhat smaller degree in the central and western Pennsylvania coal districts.

However, much has been learned since Governor Pinchot appointed a commission to research the problem of anthraco-silicosis in 1932.

Since then we have had a study on anthraco-silicosis by the United States Public Health Service which was published in 1934. There was a National Conference on Silicosis in 1936.

Innumerable meetings have been held and volumes have been written about the disease, anthraco-silicosis, or the broader coverage of pneumoconiosis, but still we have great gaps in our knowledge of these conditions.

You don't have to be a physician to know there is something wrong when a man 40 to 50 years old, who should be in the prime of life, is unable to walk up a small hill without stopping for breath.

When a man acts like this, whether it is in Johnstown, Shamokin, Wilkes-Barre, Scranton, Clearfield, Philipsburg or Pittsburgh, nine times out of 10 he has "miner's asthma". These people are handicapped and have become handicapped from inhaling silica and coal dust in the course of their employment in the mines.

Much of this disease was caused by the inhalation of dust many years ago when our knowledge of the disease was much less definite than it is today.

Many steps have been taken to reduce this dust inhalation, but have we done enough? We don't know whether miners who have started mining in recent years are as susceptible to as much disease as were the older miners.

There is a lack of regular periodic health supervision of our miners today. Dust inhalation is a serious problem which this industry must face if younger people are to be induced to enter the mines.

There is still no adequate treatment for anthraco-silicosis. However, it can be prevented. We are certain that without dust there would be no anthraco-silicosis. We also know that some dust can be inhaled by workers without causing the disease. Still, dust control is expensive; therefore, we must know how much dust control is needed.

The coal industry itself has moved forward in reducing dust in many mines. Pennsylvania's Department of Mines and Mineral Industries has undertaken dust studies in the mines and has made recommendations for its control.

Excellent cooperation from the industry has been given in the implementation of these recommendations. The Department of Health has x-rayed many coal miners and both the Departments of Health and Mines and Mineral Industries are coordinating their studies.

This activity is only a beginning, however, and much more needs to be done for effective prevention of pneumoconiosis.

In the meantime, we have a large reservoir of disabled miners who are suffering from the results of past years of dust inhalation. Some of these men are totally disabled; others are disabled to various degrees.

Under the Pennsylvania Occupational Disease Law we compensate these miners for their inability to earn a living. Last year the State appropriated 12 million dollars to fulfill this law; this year it jumped to $17 million. The Secretary of Labor and Industry tells me that these payments are estimated to reach 21 million dollars in the forthcoming year. This figure may well climb higher before it will be reduced.

Even this estimated amount will not compensate everyone who is afflicted. The present law is based on outdated scientific information.

It contains a four-year statute of limitation which forbids the compensation of those persons who become disabled from mine dust exposure but have not mined within the last four years before their disablement.

On the other hand, men are being compensated who are not totally disabled and who can perform other work. In order to correct this unreasonable situation, fair and effective disability evaluation is needed which will result in the rehabilitation and retraining of partially disabled miners. The prevention of this disease must be heavily stressed.

I have invited you to this conference to discuss these problems, to guide our State Government, to help fill the gaps in our present knowledge, to help make better use of available knowledge, and to offer us counsel where we can help.

Let us work together toward the goal of stamping out this costly disease; costly in dollars, costly in men.

H. Beecher Charmbury, Ph.D., Secretary
Department of Mines and Mineral Industries
Commonwealth of Pennsylvania

This conference on pneumoconiosis is of vital importance to all of the citizens of Pennsylvania. The term pneumoconiosis was proposed in 1867 to include all pulmonary manifestations of dust inhalation, whether the dust is injurious or harmless. Thus pneumoconiosis is caused by the accumulation of dust in the lungs.

Present underground coal mining methods do produce dust and it is for this reason that this conference is of vital importance to the Department of Mines and Mineral Industries and we are most pleased to participate in the conference.

Because of the dust forming operations in the coal mines this conference is of vital importance to the hundreds of thousands of men in Pennsylvania who have previously worked in the mines and their families, to the approximately 27,000 miners in Pennsylvania who now work underground in the coal mines and their families, and to the approximately 1,850 deep coal mine operators and owners.

By law, the Department of Mines and Mineral Industries has the responsibility for the protection of the health, safety, and welfare of the men who work in the mines. This includes the responsibility of seeing to it that the atmosphere in which the men must work is as healthy and as satisfactory as is technically possible. Underground coal mining operations, as we have them today, simply cannot be performed without dust formation but mine management must, and in most cases is making every effort possible to control dust formation and to provide a satisfactory atmosphere in which to work. Basically, this control of dust is accomplished by water spraying and by proper ventilation. In addition to the physiological hazard caused by dust the bituminous coal operator must also be concerned with the more dangerous explosive hazard.

The dust problem in coal mines is by no means a new problem. It has existed ever since coal was first mined. However, from a physiological standpoint, very little was done about the problem by government in Pennsylvania until 1932 when Governor Pinchot appointed a commission to inquire into the question of compensation for occupational diseases. The commission, in its report, recommended that a survey be made by the U.S. Public Health Service as to the nature, scope and gravity of occupational disease hazards due to dust in the anthracite coal field. This survey was made in 1933 and as a result there were a total of 25 conclusions and factual statements and 11 recommendations.

Of all these conclusions probably the most important was the one determining safe limits of dust exposure. Basically, this conclusion stated that an atmosphere containing less than 50 million particles of dust per cubic foot of air would produce a negligible number of cases of anthraco-silicosis when the quartz content of the dust was less than 5 per cent. Also, where the silica content of the dust was about 13 per cent a safe limit appeared to be 10 to 15 million particles per cubic foot. And finally, a limit of toleration for rock workers was tentatively set at 5 to 10 million particles per cubic foot.

Time of exposure to the dust also was an important factor. Except for rock workers, less than 2 per cent of the men developed anthraco-silicosis when their exposure time was less than 15 years. For men exposed more than 15 years, the percentage to develop anthraco-silicosis was a function of the amount of dust and the silica content. There was an increase in this percentage with an increase in the amount of dust and an increase in the silica.

The safe limits as listed above, however, were important because they became the guide lines for the threshold limit values adopted by the American Conference of Governmental Industrial Hygienists first in 1938 and then reaffirmed in 1960. In 1962, however, this agency adopted a new formula for determining the threshold limit value. This value now lists the millions of particles per cubic foot of air present as the threshold limit value based upon the per cent of free silica in the dust. The threshold limit value is obtained by dividing a constant 250 by the per cent of free silica plus 5. Thus if the per cent of free silica in the dust is 20 per cent the threshold limit value would be equivalent to 10 million particles per cubic foot of air.

Several years ago the Pennsylvania Department of Health made chest X-ray studies of men working in the coal mines. However, the interpretation and evaluation of these studies were somewhat handicapped because of the lack of information on the dust conditions to which the men in the mines were exposed and later the Attorney General made the decision that the Department of Health personnel had the right to enter the mines to make dust surveys. This became somewhat complicated because of the lack of the personnel's familiarity with the mines and mining operations. Two choices became eminent, either the Department of Health's personnel acquainted with dust collecting and analysing procedures would have to be thoroughly trained in mining methods and procedures or the Department of Mines personnel acquainted with mining methods and procedures would have to be thoroughly trained in dust collecting and analysing procedures. At a meeting between representatives of the two departments along with representatives of mine management and labor the decision was made to take the mining men and to train them in dust sampling and analysing work. Consequently in 1960 a joint program was developed between the two departments. Basically, this program consisted of the Department of Mines and Mineral Industries' personnel collecting the dust samples and the Department of Health's personnel evaluating the results. The Mines' personnel would count the dust particles and the Health's personnel would analyse for silica.

The Mines Department employed four qualified mine foremen for this program, two to work in the anthracite area and two to work in the bituminous area. These men had a comprehensive six weeks training program in the techniques of collecting samples and counting particles.

The midget impinger method of sampling and counting was employed. Although this method has definite limitations, which I discussed at the United States Technical Conference on Air Pollution in 1950, it is probably the most generally recognized method in use today. The results are purely empirical and give only relative values which are subject to errors in interpretation if consideration is not given to the ability of the apparatus to draw the dust into the nozzle tube, to the loss of the collecting liquid by evaporation, to the retention of the dust in the liquid, to the shattering of the dust due to impingement, to the size range of the dust, and to the settling time in the cell prior to counting.

The Deputy Secretary of Mines in each area makes the proper arrangements with mine management and labor to conduct the survey in a specific mine. The dust study personnel meets with the mine personnel and the State Mine Inspector to become thoroughly acquainted with the particular mine before the survey. The dust study personnel then formulates the program and makes the survey. Details of these procedures and operations will be presented in papers at the special session on dust control tomorrow by the Deputy Secretaries, the State Mine Inspectors, and the Chief Mine Foremen who make the dust surveys.

After the mine survey is completed and all results are tabulated the dust survey personnel report to the Deputy Secretary of Mines who in turn submits a final report to the Secretary of Mines. This report includes recommendations to correct unsatisfactory dust conditions, if any exist, and the State Mine Inspector is notified of these conditions as well as the corrective recommendations. However, if there is a serious dust condition which exists during the survey, the survey personnel notifies the Deputy Secretary of Mines who in turn informs the inspector so that the correction can be made immediately. It is then the responsibility of the mine inspector to see to it that corrective steps are taken.

After the Secretary of Mines receives the report, copies are sent immediately to the Secretary of the Department of Health, to the Superintendent of the mine and to the President of the United Mine Workers of America.

To date, since this program was instituted in 1960, there have been surveys conducted in a total of only 44 coal mines in the Commonwealth. There are 5,967 miners employed in these 44 mines. We have in Pennsylvania 581 large deep mines employing about 23,500 miners. All of the surveys thus far have been in the large deep mines. In addition to these large mines, Pennsylvania has about 1,250 small deep mines employing about 3,500 miners. The foregoing figures include both anthracite and bituminous mines and miners.

In studying these 44 mines, 3,750 samples were collected for particle counts and size analyses. In addition, 498 samples were collected for silica analyses. From these 476 time weighted exposures were calculated. Of these only 34, or about 7 per cent, were found to exceed the allowable threshold limits. Let me assure you that corrective steps have been taken in these cases.

In conclusion, I can only recommend that the Department of Mines and Mineral Industries be given additional manpower to step-up its program of dust surveys to cover more mines for the protection of more miners. The dust counting facilities are available but more manpower is needed to survey additional mines. This would require a relatively small expenditure today to protect the miners' lives and a large expenditure in the future. The amount paid out today in just two claims would practically be sufficient to double the protection against possible future payments and the savings of men's lives and disability.

William P. Young, Secretary
Department of Labor and Industry
Commonwealth of Pennsylvania

Governor Scranton, Secretaries Charmbury and Wilbar, Distinguished Delegates to this Conference, Ladies and Gentlemen –

I am pleased beyond expression that we have met together on such an occasion as this because the primary purpose of our meeting is in complete accord with the specific role assigned to us in the Department of Labor and Industry,--namely serving the best interests of all the people of this great Commonwealth.

As our Governor said, when inviting the various delegates to attend this Conference, (and I quote), "We are bringing together, for the first time, management, unions, legislators, physicians and attorneys to discuss our Pennsylvania problem of dust disease among mine workers, hopeful of reaching some more satisfactory answers to this problem than now exist."

While the problem to which we seek to find answers during this Conference is obviously one which concerns all of the men who work in our mines and their families, it is also a problem of direct concern to every citizen of Pennsylvania.

Certainly, I am not qualified, nor will I attempt, to discuss this disease from a medical or scientific point of view.

However, as this series of meetings runs its course, you will have occasion to hear from some of the foremost authorities in this field. They will have much to tell you from a medical viewpoint--much that I am sure will be of interest to every person here.

What this disease does to the bodies of men is the main concern of each of us, and the ultimate good that could come from meetings such as this is, the elimination of the ravages of this destructive illness.

But there are other factors, too, that hold a great deal of interest for you and me and all of us, as citizens and taxpayers. And I'm referring to the cost of paying the claims that are filed each year under the terms of the Occupational Disease Law.

You will learn through the course of these meetings that the sums of money expended yearly by the Commonwealth have sky-rocketed during the past 23 years.

In the first year that the law became effective, less than half a million dollars was paid by the Commonwealth to satisfy legitimate claims under the law. This involved some 200 claims against the fund.

However, you will learn that for the fiscal year 1964 the sum expended was not a half million but 17 million dollars.

And a forecast, based on the best information available to the Department of Labor and Industry, is, that this sum may be expanded to astronomical figures in a short period-of-time, if things continue the way they are going.

One of the reasons that the cost for supporting claims against the Occupational Disease Fund has reached such irrational figures is the fact that the bill is paid almost entirely by the Commonwealth--from state tax money.

Now, this was not always true.

With the inception of the Occupational Disease Law, the payment of claims was shared by the Commonwealth and the employer.

However, in 1953, the legislature saw fit to amend the law to this extent--that in all cases where death or disability cannot be conclusively proved-to-be the result of a last exposure, the Commonwealth would be responsible for full payment of the claim.

Meanwhile, experience has taught that it is practically impossible to prove that death or disability is caused by a last exposure.

Thus almost every claim paid under the Occupational Disease Act in Pennsylvania is paid nearly one hundred percent by the Commonwealth.

By comparison this is a very unusual situation.

True, there are other states that pay one hundred percent of the claims, but in almost all cases they are small states and do not begin to approach the amount that is paid by the taxpayers of Pennsylvania.

In 1966 it is estimated Pennsylvania will spend 21 million dollars--I repeat, 21 million dollars--for Occupational Disease claims.

Our present experience is that the cost goes up by about 2 million dollars a year.

That this money is paid out in a good cause is obvious. I pose no argument on this point.

When a man contracts a chronic disease--such as I understand pneumoconiosis to be--and this during the course of his legitimate occupation and through no fault of his own--it is small recompence that he be reimbursed in terms of dollar benefits.

The money paid one who is the victim of an occupational disease, such as this, is not a cash sale.

In other words the payment of a claim, under the Occupational Disease Law, is not equal to the impairment to health which the victim has suffered, nor was it ever intended to be.

In terms of money, there is no value which can be placed upon a man's health.

But this is the only tangible, concrete way thus far conceived that we can acknowledge the debt that we owe, as members of the Commonwealth society, to those who have given of themselves in service, and in turn become permanently injured in the performance of that service.

We would be less than human if those who suffered in the performance of their duties were left to fend for themselves with no attention or recognition coming from the rest of us.

And so I am sure we can all agree that the payment of claims under the Occupational Disease Act is not only a humane thing to do, but is a part of the responsibility of all the citizens of the Commonwealth.

To me it seems clearly obvious that a problem has developed when the amount of money expended jumps 42 hundred percent in a period of 23 years.

Something is obviously questionable about a function like this, and I believe you will agree with me when I say, it is time we start finding some new and better answers.

Now lest someone misinterpret what I am saying here, let me try and make this one point clear.

I'm not here advocating any reduction in the amount of money we pay to any legitimate claimant under the Occupational Disease Act.

It is even possible that legitimate claimants are not receiving enough compensation.

But my point is this Conference will bring together a good cross-section of the best opinion in all the fields involved in this situation.

There will be doctors and men of the medical profession who will speak to us of their experiences in prevention programs in other states and other countries.

There will be authorities in the field of industry--particularly the mining business--who will give us their viewpoints on dust control.

Other representatives of the government of the Commonwealth will bring us information based on their experiences in the anthracite and bituminous mine areas of Pennsylvania.

Representatives of organized labor will tell us during this Conference what their feelings are regarding the impact of the Occupational Disease Law on our Commonwealth.

Attorneys will express their viewpoints.

Thus it can truthfully be said that we will have available to us during these meetings millions of dollars worth of talent and knowledge.

It is our job as delegates to use wisely and with purpose all of this brainpower which is being placed at our disposal to find answers with which we can live.

To all of you who have come to this Conference seeking knowledge and the development of plans and ideas, I most heartily wish every success.

PNEUMOCONIOSIS PREVENTION IN GREAT BRITAIN

John Rogan, M.D., Medical Director
National Coal Board
Great Britain

I should like to say how much I appreciate the privilege of attending this large and important Conference.

Pneumoconiosis is likely to become a serious problem in any coalfield whenever the techniques of coal extraction have outpaced those of dust suppression and ventilation.

In the early decades of last century there was a rapid intensification of coal-getting in Britain. Ventilation lagged behind and soon evidence that pneumoconiosis was widespread among the miners was forthcoming from all the coalfields. Working conditions gradually improved and by the 1870's coal mining was regarded as a healthy occupation. This sequence of events was to be repeated 100 years later when the lessons of the previous century had apparently been forgotten. In the 1920's there began a steady and sustained rise in mechanization which continues into the present and which must continue in the future if coal is to be able to compete with other sources of power. By the 30's there was growing concern at the rapid increase in cases receiving compensation for silicosis in South Wales. The Medical Research Council, at the request of the Home Office, carried out a classical investigation in that coalfield. They discovered that only a small proportion of men who had worked for long periods in rock were affected by silicosis. Pneumoconiosis on the other hand was present throughout the coalfield though it varied widely in prevalence and severity in different areas.

These findings were to have a number of important and varied consequences. The compensation law was changed in 1943 and pneumoconiosis became compensable for the first time. Within two years the annual certification rate had soared from hundreds to a peak of over 5,000 cases in South Wales alone. The coal industry in that coalfield, still in private ownership, embarked belatedly on a systematic program of dust suppression. This program could not of course produce early results and certifications continued at a high level. Many men who were certified were capable of doing light or moderately heavy work yet by law they were excluded from the industry. Some thousands of Welsh coalminers with pneumoconiosis were unemployed and living in conditions of social and economic stress. After carefully considering the situation the responsible authorities concluded that it would be better to re-employ certified men in the industry provided that all respirable dust in their working places in the mines was kept within limits thought to be reasonably safe. These limits were based on the results of the Medical Research Council's earlier research and on what the mining engineers regarded as being practicable. The coal industry, which meanwhile had come under public ownership, undertook to keep the dust below the agreed limits wherever pneumoconiosis cases were re-employed – should this be permitted. Moreover, it was just as important to prevent new cases of pneumoconiosis arising, as it was to prevent existing cases getting worse and the industry stated its intention to try to reduce the dust below the agreed limits universally throughout all the collieries in the country. In the light of these undertakings the law was changed again in 1949 and pneumoconiosis cases who had been compensated were allowed to re-enter the industry. Within a few years the number of unemployed pneumoconiosis cases in South Wales had fallen to hundreds instead of thousands.

Until the early 1950's the pneumoconiosis problem seemed to be concentrated in South Wales. About this time however the certification rate in that coalfield began to fall, largely because most of the potentially certifiable men had already been certified and to a lesser extent because dust suppression was beginning to show its effects. But the rate in the other coalfields, Scotland, the North of England and the Midlands rose steeply. Isolated radiological surveys of collieries in the North of England showed an appreciable prevalence of pneumoconiosis, not usually as high as in South Wales but quite high enough to justify the industry's earlier decision to extend dust suppression to all the coalfields.

The dust suppression campaign then began to gain momentum and effectiveness. Much experience in the techniques of dust suppression had been obtained in South Wales but mining conditions varied widely from coalfield to coalfield. The National Coal Board therefore set up a Dust Conference attended by mining engineers from all coalfields who had special responsibilities for dust suppression and by representatives from the Scientific and Medical Departments. The conference met regularly – and still does – and enabled the experts to exchange ideas, to plan experiments and to disseminate information throughout the industry.

Meanwhile a logical system of dust sampling was being evolved. The general principle underlying the system was that the sampling effort should be greatest and the sampling most frequent where the dust conditions showed the largest degree of fluctuation. Clearly much less sampling was necessary in conditions where the dust levels tended to be static. The work of the mining engineers in suppressing dust was thus regularly monitored. From the early 1950's to the present it has been possible to keep the dust below the agreed limits in about 90% of work places where coal is extracted. In rock work, where a much more stringent limit has been in force, the figure has been lower – about 70%. The dust suppression campaign received additional impetus from a provision of the Mines and Quarries Act of 1954 which stated that "It shall be the duty of the Manager of any mine to ensure that the giving off of dust of such character and in such quantity as to be likely to be injurious to the persons employed, is minimized."

Though the general intention of this provision was clear enough the wording was somewhat odd. When the Act was passed no one in Britain was in a position to say how much of the various kinds of mine dust was likely to be injurious. Steps were however being taken to find out. You may remember that our agreed dust limits were to some extent empirically determined. When they came into force in 1949 it was generally recognized that research to establish safe dust limits on a scientific basis was essential. This research could not be other than long term as pneumoconiosis developes slowly and after long exposure in conditions in which dust is suppressed. The National Coal Board were invited to undertake it and they agreed, launching the project in 1953 under the title of the Pneumoconiosis Field Research. When the Pneumoconiosis Field Research was planned it seemed unlikely that it would achieve its object, the establishment of scientifically determined standards of coal mine dusts, before 1970. This was a long time to wait. What was to be done to safeguard the lungs of British coalminers in the intervening years? True dust suppression was now being applied and the degree of dust suppression obtained was being monitored by regular dust sampling. But at any colliery the acid test of the effectiveness of dust suppression was whether or not new cases of pneumoconiosis were arising and established cases getting worse. The only way of finding out was to x-ray the chests of the whole mining population at regular intervals, colliery by colliery. The Board approved this idea in principle. After full consultation with the Trade Unions in the industry they too gave their approval. Much thought was given to the question as to whether the x-ray examinations should be voluntary or compulsory and it was decided that they should be voluntary. A target of acceptance of 80% by the men was set. Firm guarantees were given by the Board's medical staff that in every case absolute professional confidence would be observed and that in no circumstances would information about a man be passed to a third party without his consent. A period of 5 years was selected for the interval between colliery surveys – to be extended or shortened later in the light of our findings. From our experience with the Pneumoconiosis Field Research we judged that it would be possible to obtain full sized chest x-ray films of good quality utilizing specially designed mobile x-ray units. Ten such units were constructed and the scheme began to operate in 1959. By 1963 all our collieries had been surveyed. During this "first round" 460,000 miners were x-rayed with an acceptance rate of just over 85%. The second round of surveys began this year.

At this stage it may be helpful if I indicate briefly the administrative framework concerned with the pneumoconiosis prevention program in Great Britain. At Government level there is the National Joint Pneumoconiosis Committee which meets under the chairmanship of the Parliamentary Secretary of the Ministry of Power. The following organizations are represented by experts and administrators, the Ministry of Power itself, the Ministry of Health, the Ministry of Pensions and National Insurance, the Ministry of Labour, the Board of Trade, the Medical Research Council, the National Coal Board and the Trade Unions. It is the responsibility of this Committee to keep the pneumoconiosis problem under

regular review and to make appropriate recommendations to the constituent bodies. The Ministry of Power is responsible for insuring that the law relating to injurious dust in coal mines is observed. The Ministry of Health is responsible for the provision of domiciliary and hospital services. The Ministry of Pensions and National Insurance is responsible for the compensation system which is operated on a national basis in contrast to the American system based on the States. The Ministry of Labour and the Board of Trade are concerned with rehabilitation and the employment of pneumoconiosis cases. The Medical Research Council undertakes fundamental research on pneumoconiosis. The National Coal Board which is of course a public corporation running the industry and not a Government department carries out dust suppression and dust measurement and through its Medical Service is responsible for medical control. The Trade Unions exercise a watching brief on behalf of their members.

Research on pneumoconiosis prevention in Great Britain has been of inestimable value. Research on dust suppression in its fundamental aspects is carried out by the Mining Research Establishment of the National Coal Board. It has been shown that dust suppression is likely to be most successful if the dust is suppressed at its point of origin, that is, where the machine makes contact with the coal. Once the dust is airborne it is extremely difficult to capture it by the various techniques which are available. Machine design is therefore of the greatest importance and this is the responsibility of the Board's Central Engineering Establishment. Machines designed without regard to dust suppression and subsequently adapted are never very satisfactory.

Research on dust measurement is carried out by the National Coal Board and by the Ministry of Power. At present the industry is moving from intermittent sampling with the thermal precipitator to whole shift sampling with our long running thermal precipitator which automatically samples throughout the working shift. Research is now in progress on sampling by mass of dust rather than by the number of particles. Mass is likely to be the more reliable parameter. It can be determined more accurately and rapidly than the number of particles which of course have to be counted laboriously under the microscope. Though a great deal of work will be involved we hope to introduce mass or gravimetric sampling in a few years time in all our collieries.

Medical research is carried out principally by the Pneumoconiosis Research Unit of the Medical Research Council and by the Pneumoconiosis Field Research of the National Coal Board. The Pneumoconiosis Research Unit is mainly concerned with the natural history of pneumoconiosis and the Pneumoconiosis Field Research with its prevention so the work of both groups overlaps to some extent. A short description of the Pneumoconiosis Field Research may be of interest particularly as parallel studies are now in progress in the United States. Its origins I have already described. Its aims can be defined thus ..... "To determine how much and what kinds of dust cause pneumoconiosis and to establish what environmental conditions should be maintained if mineworkers are not to be disabled by the dust they breathe during the course of their work." The plan of the research was simple in conception but not so easy to execute. It was decided to conduct the research at a representative sample of 25 collieries with a manpower of about 25,000 men. Detailed measurements were to be made of the dust so that the cumulative dust exposure of each man could be established both in terms of quantity and quality. The colliery populations were to be x-rayed at five yearly intervals. Thus it would be possible to match the dust conditions with the onset and progression of the disease. When the research was planned pneumoconiosis was largely thought of as a radiological entity. When it had been in progress for a few years, increasing attention was focused on bronchitis in coal miners, not necessarily accompanied by pneumoconiosis. It was therefore decided that the second and third x-ray surveys should be supplemented by a questionnaire of chest symptoms and by a simple test of ventilatory lung function – the $F.E.V._1$ sec. Two surveys have now been completed and the third is in progress.

Now I should like to outline the contemporary pneumoconiosis problem in Great Britain in the light of information obtained from medical supervision of the industry and from medical research.

The prevalence of pneumoconiosis of all types varies widely, just as it does in Pennsylvania. Surveys carried out under the Periodic X-ray Scheme between 1959 and 1963 show a prevalence in all coalfields of about 12%. It ranges from about 6% in Scotland to 25% in South Wales. Over the five year period

85% of our miners volunteered for x-ray. The target has now been moved up to 90%. Comparisons of prevalence have to be made with care owing to the great difficulty in securing consistency in x-ray interpretation. Not only do radiologists with long experience of pneumoconiosis differ in their standards of diagnosis from each other but each radiologist tends to change his own standards from time to time. This problem of observer variation not only affects the assessment of prevalence, it also makes the assessment of progression, i.e. the advance of the disease from the early to the later stages, much more difficult. It is receiving our closest attention but we have by no means solved it yet.

Bronchitis, diagnosed by questionnaire, also varies widely in prevalence ranging from 9% to 43%. Though the relationship between bronchitis and pneumoconiosis is still obscure, we have noted that a high prevalence of pneumoconiosis at a colliery tends to be associated with a high prevalence of bronchitis. We have also noted that when we correct our data to allow for the effects of age the symptoms of bronchitis tend to increase as the pneumoconiotic condition advances.

Simple pneumoconiosis by itself seems to cause comparatively little disability – indeed a proportion of men with simple pneumoconiosis appear to have perfectly normal lung function – but moderate or severe disability is usually associated with complicated pneumoconiosis or progressive massive fibrosis. The risk of developing complicated pneumoconiosis, which affects about 1% of the British coalminers, increases steadily as the lungs become progressively involved in the simple pneumoconiosis process. Though complicated pneumoconiosis has been studied intensively by British research workers for many years it has to be confessed that they are no nearer an understanding of its causation.

Bronchitis in general tends to cause more disability than simple pneumoconiosis whether or not pneumoconiosis is present as well. Though one suspects that bronchitis is caused or aggravated by mining conditions it is seldom possible in the individual case to decide whether a miner's bronchitis is occupational in origin or not. Only when the prevalence of bronchitis in a mining population exceeds that in the neighbouring community can the excess be attributed to occupation. Even then it is difficult to be dogmatic as in some cases coal miners may be recruited from the less healthy part of the community.

A word about compensation. This forms part of our national insurance system, the cost being met partly by a contribution from all employers, partly by a contribution from all workmen and partly by general taxation. The system is administered by the medical staff of the Ministry of Pensions and National Insurance – fortunately the Medical Service of the National Coal Board have no responsibility for it – otherwise it would be much more difficult to maintain the trust and confidence of our mineworker patients. Once a man is certified as suffering from pneumoconiosis he is awarded a pension based on an assessment of his loss of faculty – that is his loss of function and of the capacity to enjoy a normal life. The pension is graded in steps from 10% to 100% for a totally disabled man and a workmen who receives it is free to earn as much as he can in addition. The system is open to criticism on two grounds. First, a lot of money is spent paying small pensions to the many men who are only slightly disabled – this could be better spent in augmenting the pensions of men who are seriously disabled. Secondly, insurance benefits for pneumoconiosis or for pneumoconiosis with bronchitis are much higher than they are for bronchitis alone which may be just as disabling. Many doctors in Britain feel that the time is ripe to abolish the difference in benefit between occupational and non-occupational diseases especially as it is virtually impossible to draw a dividing line between the two in many cases.

When I was asked to speak on "Pneumoconiosis Prevention in Great Britain" I agreed with no more than the usual apprehension. But later I was startled to find this title under the general heading "Successful Pneumoconiosis Prevention Programs Elsewhere." I had to ask myself just how successful is our program.

In the first place I have no doubt whatsoever that had our program not been pursued with vigor for a good many years the pneumoconiosis problem in British coalfields would have been infinitely worse than it is – indeed I doubt if the social conscience of the nation would have allowed coal mining to continue if there were a reasonable alternative source of power. Secondly, there have been indications in the last few

years that the program is having a decisive effect. The annual certification rate for pneumoconiosis is now running at about 1,000 cases a year whereas in the forties and fifties it swung around the 4,000 mark. The results from the periodic x-ray scheme indicate a prevalence of about 12% in British coal mines in 1964 compared with the figure of about 15% for the same mines five years earlier. A more sensitive index of the change in environmental conditions in the last two decades is the prevalence of pneumoconiosis in the comparatively young men, for example, the under 35's. In 1959 the rate for all forms of pneumoconiosis in the under 35's was 16 cases per 10,000 men employed. By 1964 the rate had fallen to 3.

The only figures relating to pneumoconiosis which have shown little change in recent years are those for death benefit. However, deaths for which benefit is paid occur most commonly in the 65 to 74 age group. Men presently dying in this age group entered the coal mines before the first world war.

It takes a long time for pneumoconiosis prevention programs to be fully effective. The present pneumoconiosis problem is an inheritance from the past. We carry a heavy responsibility to ensure a happier legacy for the coal miners in future years.

THE NORTH CAROLINA PNEUMOCONIOSIS PREVENTION PROGRAM IN DUSTY TRADES

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This North Carolina report to Pennsylvania was not visualized originally to be the grand salute to some 200 North Carolina employers it now proves to be. While our story could not match the vastly larger populations involved in Great Britain or the Commonwealth of Pennsylvania, it does permit tribute to the sincerity of purpose and resultant successes of a very few Tar Heel employers.

Our story has confirmed the already known facts about silicosis cases: insidious onsets, long and slow progress as their detection is delayed, their positive diagnosis at some particular time deceptive and challenging, their prognosis depressing. The lung pathology of our cases usually has increased progressively after removal from exposure. Small wonder then that our North Carolina employers of so few men, relatively, have needed every encouragement and help as they have struggled with the drab and undramatic problems of dusty work environments! They could see little, if any, tangible evidence that what an employer was doing did have real beneficial effect upon his employees' health. We salute them because we have demonstrated at home that legislation and governmental activity alone do not provide job health protection.

Asbestosis and silicosis are two of 27 occupational diseases or disease groups listed by North Carolina General Statutes as compensable; they have come to be known as the "dusty trades". They are defined as occupational diseases arising out of or in the course of employment of persons engaged in or about to engage in an occupation which has been found by the North Carolina Industrial Commission to expose them to the hazards of asbestosis and/or silicosis. The Commission must designate, by order, each industry found subject to such hazard, and shall notify the employers therein. Today, we shall concentrate upon silicosis as we report to you some North Carolina experiences with pneumoconiosis in the dusty trades since 1935.

Reason for Existence

Since the turn of this century, increasing numbers of our dusty trades employees had been developing pneumoconiosis. It was evident that even in those days such might not be intended by most employers. Employers then had no adequate information of standards as they do today[1] which, if met, normally would assure the job-related health of their employees. They received no recommendations with reference to methods or procedures readily enough available to them, even in the earliest days of our story, to prevent excessive exposures, or to protect their employees, to reduce the justified employee claims for damages employers were facing. For that matter, they had no reasonable protection against the unjustified claims, the unwarranted suits, and the occasionally unfair civil action by an employee seeking excessive monetary damages when matched with the minimal personal injury which may have existed. No one employer was legally responsible to some one employee claiming damage. Employers were increasingly subject to civil suits, I am told. With no official guidance, they had no legal or financial protection even if they did everything they knew to do to protect their employees' health.

Employees had little protection and no recourse but the civil courts after they had, or believed or claimed that they had, acquired a disabling disease. In this background a positive legislative program took shape as early as 1929. We shall summarize briefly initial studies made promptly after 1935 legislation, and enough of our current activities and current knowledge to illustrate certain beneficial results our records and reports will confirm.

Legislation

The pertinent North Carolina legislation is grouped broadly into (1) that enacted in the period 1897 to 1931, materialistic, corrective or compensating, primarily directed towards administrative efforts; (2) that enacted in the period 1935 to 1959, personal, preventive, or protective, primarily directed towards public health action (Table 1).

Program Responsibilities

Prior to 1935 the program was incomplete. It involved the confirming of the existence of occupational disease, but only after the individual had an irreversible disease, it provided for medical costs to limited amounts, and perhaps limited compensation of the injured or diseased person. Then a truly protective type or preventive type of program against pneumoconiosis took shape. Even then one could predict that years would pass before any tangible evidence of human benefits would appear.

Since 1935, the program responsibilities within the State have been readily enough definable (Table 2). The Department of Labor, Division of Standards and Inspection, has specific statutory responsibilities for mines and quarries and for promulgation of pertinent rules and regulations. One of its Divisions is charged with the establishment of standards for work places and working conditions, and this was spelled out for mines and quarries as early as 1942. The Department sets standards and makes rules and regulations to protect from accidents and occupational disease. Dating back to 1897, it had inspected for compliance and enforced the prescribed requirements.

The North Carolina Industrial Commission was established in 1929 as a Division of the Department of Labor, but with a separate and independent Commission to implement certain prescribed duties and rules, and Commission authorities were defined. Workmen's Compensation and Insurance were set up to apply when five or more persons would be employed by the same employer in North Carolina.

In 1935 the State Board of Health entered the picture by an abrupt statement in the Article covering Workmen's Compensation, "When an employee and the Industrial Commission are advised by the State Board of Health that an employee has asbestosis or silicosis ----" several significant actions by the Commission, the employer, and the employee would be required. Thus began the North Carolina "dusty trades" program.

Please recall that the Industrial Commission was required in 1935 to designate by order each industry subject to the hazards of asbestosis and/or silicosis, and the Commission was required to notify such an employer before any examinations could be required, which would be examination of the work environments to determine positively the presence or absence of hazards to employees working therein and examinations of employees. When the medical and health program was introduced, the problem of fees for physicians and and other medical diagnostic and therapeutic services appeared; hence, the Industrial Commission for years has established and published average fees which the Commission has recommended as reasonable for employers or insurers to pay for the many medical and health services involved and required of the employer by law.2

In 1935 the Industrial Commision's Advisory Medical Committee was defined and required, made up of three physicians recommended for appointment by the Industrial Commission who must be approved by the Governor, to serve in a manner prescribed in General Statutes. By 1936, this Committee had begun study of the actual status of silicosis. The present Committee Chairman, Doctor Herman F. Eason, directed those original occupational disease studies which showed how justified this type of program had been. We shall show you factual data assembled during the past four years in order to analyze the 29-year program results.

The State Board of Health set up its organizational unit to investigate and study the occupational diseases of the dusty trades by late 1935; at the same time the Advisory Medical Committee, in effect, became a joint agency of the Board and Industrial Commission, to notify the employee and the Commission when the person was suspected and proven to have a pneumoconiosis; to report to the Industrial Commission upon the basis of the Committee's and the Board's records and reports; and finally, to make specific recommendations which would favor adjudication for or against payment of compensation for damage to the employee's health, and to give the evidences pertaining thereto. The Board initiated active preventive efforts, or the protection program against pneumoconiosis. Work environments exposing employees to their hazards would be surveyed in detail by industrial hygiene engineers. The employees of the dusty trades' employers would be examined by the Advisory Medical Committee members, and by physicians

employed by employers, to help employers comply with their statutory obligations. The Board was ready to recommend to the employee, the employer, the Industrial Commission, and the Department of Labor, those health-protection actions which each should undertake, separately or together.

By 1957, new legislation included more specific assignments to the State Board of Health: to investigate the causes of occupational diseases so as to prevent them; to make such studies and research concerning prevention of disease, promulgation of life, promotion of the physical health and mental efficiency of the State; to make recommendations for elimination or reduction of occupational health hazards; and to direct the attention of the State to health matters which would affect the industries, property, health and lives of the people of the State. Thus, by 1957, North Carolina had bonded together many health and socio-economic factors.

The employer, in obtaining a pre-employment physical examination of any person about to engage in work exposing to the hazards of silicosis had been required early to provide to the Advisory Medical Committee for the applicant a complete and factual work history as well as a medical and health history, all in a form prescribed by the Industrial Commission and furnished for the purpose. This physical examination, along with a chest x-ray film, continues a well recognized and standard procedure. Employers also are required to provide for annual physical examinations of their exposed employees, with chest x-ray films, to prove their sufficient health to allow continuing employment even though exposed. The employer is required to prove his capability, by adequate insurance or other method, to pay compensation to an employee who might develop future pneumoconiosis. Even today, however, an employer occasionally will neglect or completely ignore one or more of these several serious responsibilities.

Employees were given specific responsibilities; for example, they are required to submit to examination; to report factually their past medical history as well as past employment, and nature and time periods for each; to report every "injury"; to accept recommendation for removal from specified exposure when ordered, or else to lose their compensation rights in prescribed manner.

Procedures

This system had developed by evolution since 1935, but a procedural guide was formulated and published for the first time only two years ago after approval by the State Health Director and the Chairman, North Carolina Industrial Commission.[3]. This guide listed the activities required of all I have mentioned. They include environmental surveys or industrial hygiene services furnished by the State Board of Health Occupational Health Section; Advisory Medical Committee physical examinations; the preparation of records and reports involved; and finally, the specific authenticating and preserving of permanent reports and records which are retained evidences with reference to compensation or denial thereof for asbestosis and silicosis.

The industrial hygiene survey of the dusty trades' work environments apply standards long published as Threshold Limit Values (TLV)[1] which are republished and distributed free to employers, local health departments, physicians, and all others concerned. Time does not allow a detailed discussion here of the survey techniques which involve the conventional impingers, high volume samplers; velometer, and thermo-anemometer air measurements; fume sampling by Greenberg impinger; laboratory particle size and count examination; free silica quantitative analysis. Respirators are checked for proper selection, wear, and effectiveness. Deficiencies and recommended corrective measures are reported to the employer.

The physical examinations of employees comprise four types: first, pre-employment, which every employer must provide before he can employ an applicant legally for dusty trade work; second, annually as ordered by the Industrial Commission; third, special examinations by the Advisory Medical Committee usually undertaken because of significant, unusual, complex, and repetitious examination findings, or because of a claim filed for compensation or just so the Advisory Medical Committee can furnish comprehensive and substantiated medical findings; fourth, the Advisory Medical Committee is obligated to make three examinations of persons adjudicated as compensable, at one-year intervals, and to submit a final written report which all members shall sign.

Referral examinations required by the Industrial Commission on behalf of the Advisory Medical Committee as well as where compensation is claimed, or has been awarded, are undertaken in one of the State Hospitals and include recording of a complete work history, a complete medical history, performance of a complete physical examination with the normal laboratory examinations, plus all additional laboratory examinations indicated by the work or medical history or the physical findings. In addition, complete pulmonary function tests are made to include lung volume and capacity, ventilation, distribution of inspired air, mechanics of breathing.[3]

Diagnosis requires confirmed work exposure to a proven causative agent of sufficient quantity, size, and content (TLV); physical examination findings; radiographic evidence; pulmonary functional deficiency(ies). Estimated disability is based upon known duration of pathology; rate of consistent progression radiographically demonstrated; pulmonary functional deficiency; and clinically confirmed related pathology.

As a result of all physical examinations, the Advisory Medical Committee either determines the safe employability for another year of each person examined or provides a positive diagnosis as a reason why an employee should not continue future exposing employment. Notifications are made to all concerned by the Section Chief, Occupational Health Section of the State Board of Health. As might be expected employers of larger groups usually have at least one physician conduct examinations of their employees independently of the Advisory Medical Committee's examinations. The Committee encourages and assists them in every practical way. Frequently, too, the company's physician joins the Committee at the time of the latter's pre-employment or periodic or referral examinations.

As a result of the physical examination system the Advisory Medical Committee diagnoses silicosis when justified, and assigns a clinico-radiographic category which has been variously called grade or stage or category I, II, and III in increasing order of severity. In the films and records and the histories prepared and left behind by numerous physicians and engineers during the past 29 years, there is a surprising consistency, even today, in the expressed exposures, disease grades, and diagnoses recorded. The diagnosed grades appear compatible also with the recommendations of experts on international classification of radiographs of the pneumoconioses.[4]

All records and reports covering industrial hygiene surveys, physical examinations, Advisory Medical Committee reports, referrals and referral reports, and all correspondence with employers and employees concerned, are maintained by the Occupational Health Section. In addition, all films with positive pathology are retained permanently. Negative films are not retained indefinitely. So much for background now as we turn to some results of this program.

We mentioned earlier for your consideration the findings of studies made 1936 to 1938[5,6] and of a recent four-year analysis of our 29-year program. One interested in our North Carolina data ought to review certain references particularly pertinent to North Carolina's early and long-term experiences.[5-12]

Program Activity Report Data

The consistency of our data is readily subject to challenge. You will detect certain peaks and valleys in the figures (Table 3). A North Carolina weakness of warning to all has resulted from the "occupational hazard" created by State employment practices; namely, the keeping or frequent losing of those qualified personnel required by the State Board of Health to carry forward the dusty trades program leaving large vacuum areas for the x-ray as well as medical examination of exposed employees who should have been studied consistently; for example, one year when x-ray technicians left the Board there were only 429 chest x-ray films made while in another year we have had up to 9,000 chest films for the study of actual and potential pneumoconiosis. There were two periods during which the activities went on without a physician on the Board's staff for the purpose. Only one physician has served longer than three years. This reflects in a wide range of the annually diagnosed cases of silicosis; for example, only three in one year but 56 in another. Other factors also enhanced some of the wide variations. In some years there were no industrial hygiene surveys made, since there was no Board personnel for such, while in another year as many as 302 were done (Table 4). In turn, all of these factors have contributed to the wide range of annual numbers of cases compensated, zero to 47, and their preponderance in recent years.

The exposed population has varied considerably. Prior to 1955 there was a fairly steady number of employees. In 1955 there were 565 employees exposed to hazards of asbestosis while in 1963 there were 746, an increase of 25 percent in the nine year period, and the number currently is increasing considerably. In 1955 there were 2,772 employees exposed to the hazards of silicosis while in 1963 there were 5,555, an increase of 50 percent.

We have seen the incidence of silicosis by time of diagnosis, about one third of all cases having been diagnosed in the past ten years (Table 3). The effects of the nature of exposure might have more interesting relation if we knew the exposed populations better, but we don't except recently (Table 5). How long the average of our 603 diagnosed silicosis cases has been exposed cannot be confirmed, but we can show that the average employee started this type of work in North Carolina at about 20 years of age. The average age at time of all so diagnosed has been 50 years. We believe our average case of silicosis has worked about 30 years before diagnosis. In the past ten years, the average age at initial diagnosis of 178 cases has been confirmed as 50 years, for Silicosis I has been about 50; for Silicosis II, 51; for Silicosis III, 58 (Table 6). We can see also increasing ages existing for S II and S III diagnosed in the past 10 years.

A limited number of employers have acquired most of the cases of silicosis. Ten employers have had 218 cases; this means 5.1 percent have had 36 percent of all cases (Table 7). Thirty of 194 employers, or 15.4 percent, have had 360 cases or 60 percent of all the cases (Table 8 and Table 9).

The extent of pathology arranged by grades of silicosis irrespective of length of exposure is revealing (Table 10 – See also Fig. 1). Fifty-one percent of 603 cases have been S I, 33.5 percent S II, and 15.5 percent S III. We find also that the more cases an employer has had there were usually proportionately larger numbers of S II and S I cases, respectively by grades (Table 11). Earlier North Carolina data on exposure to pyrophyllite[4] which showed increasingly greater over-all incidence with longer exposures (Table 22) still applies generally, but this is difficult to compare directly with our later and over-all data because the degrees of exposure have changed. Similarly our early data on exposures to mixed dusts, e.g., mica and pegmatite, showed not only increased incidence with increasing exposure periods but also approximate doubling prospect of diagnosed silicosis with every twofold increase in average dust concentration above 10 million particles per cubic foot of air[6] (See also Fig. 2). This latter had proven true in other types of exposures. Our current trends[2] and recent data encourage us as well as some of our employers, too.

Evidences of Trends

To show that work places are improving by reducing or almost completely controlling the hazards of silicosis we have selected some typical examples from industrial hygiene survey report files (Table 12).

There is evidence of positive case reduction (Fig. 3). This has been achieved by:

a. Better and more physical examinations, especially pre-employment, but also the periodic and special examinations
b. Closer personnel scrutiny

Compensation is definitely downward for asbestosis; it is at a peak now for silicosis 29 years following institution of this program, but there is beginning slight evidence that it is, or very soon will be, falling. Seventy-nine percent of all claims paid for silicosis have been during 12 years, 1949-1962.

Some specific examples drawn from the past ten years will illustrate differences between firms who have conscientiously implemented this program in North Carolina on their own choice as well as obligated by law, and others who have not. For a discouraging example consider a pyrophyllite mining and milling firm which has consistently not implemented recommended improvements (Table 13). This firm during the past ten years has had an over-all average age of employees at time of initial diagnosis of silicosis of only 36 years, 14 years younger than our general average of 50. Does this mean their silicotic employees worked only 16 years, or that they may have had no medical program? For the opposite, a firm that has undertaken appropriate remedial engineering actions and maintained medical surveillance during the same

period, while exposing employees to a serious hazard in granite quarrying and crushing, extended an over-all average age at time of diagnosis from an original 50 to 57.5 years (Table 14). Their earlier silicotic employees worked 30 years (average) but more recently they will work at least 37 years! Contrast that with the first firm's record (Table 15). Furthermore, consider that during the past ten years this second firm has had only three Silicosis II cases and only one Silicosis III case. The employee/case ratio for pyrophyllite operations has been 75/37 while for the granite operation it has been a far better 300/46.

Since 1935 there have been 603 cases of silicosis diagnosed, an annual average of 20.8. Five hundred and ninety of these were employed by 194 employers; there were 10 cases whose employers were uncertain as responsible for their silicosis, and there are 3 cases which were thoroughly unclear in their origins. A study of the distribution of the 590 is worth while before reviewing case incidence reduction (Tables 5-11).

In 1963 one of our dusty trades employees had only 5.5 percent as much chance of a diagnosis of silicosis as he had in 1935; 8.4 percent in 1962, and 10 percent 1952-1961, as he had in 1935. The program's effectiveness can be listed another way:

Newly Diagnosed Cases of Silicosis and Asbestosis (Annual Average)

Calendar Years	Numbers Diagnosed/Number Exposable Employees Examined	
	Silicosis	Asbestosis
1935-1937	1/44	1/100
1938-1943	1/100	1/219
1944-1949	1/115	1/383
1950-1955	1/125	1/3764
1956-1961	1/411	1/4006
1962	1/523	1/1696*
1963	1/787	0/6296
Total 29 Years	1/183	1/682

*Includes three long-suspected cases.

For the first time in 1962, then again in 1963, only Grade I Silicosis cases, 13 and 8, respectively, were diagnosed; only Grade I Asbestosis cases were found in 1962, no cases in 1963; more advanced Grade II and III cases of silicosis were found during every year 1935-1961.

Death certificates in North Carolina the past ten years have revealed 9 deaths with asbestosis as primary cause, at an average age at death of 54.5. These employees were all white, only one female. There were 83 primary silicosis deaths reported during the same period, all male; only 7 non-white, with an average age at death of 62 years. No trend is pictured at this time.

Program Costs

Silicosis continues to be the occupational disease of primary monetary expense to North Carolina employers with asbestosis second, yet there are only 200 dusty trades employers (Table 16). None of our data reflect the other greater costs to these employers created by diagnosis of silicosis. These are loss of production leadership and supervision usually available only from such experienced personnel, loss of skilled production, higher insurance rates, higher insurance costs, limited medical costs.

A total of $2,914,462.00 has been paid by all employers against all employees' claims for all compensation and medical costs awarded by the North Carolina Industrial Commission during the period 1937-1962. The annual average was $112,095.00. From the total, 65 percent ($1,914,777.00) went to only 435 employees with silicosis and 36 with asbestosis; 70 percent of the compensation costs paid for all preventable occupational diseases went solely to these two diseases; on the other hand only 8.7 percent of the total medical costs for all occupational diseases; payable only after diseases had developed, went

to silicosis and asbestosis. Total medical costs were only 17.8 percent of the total costs paid by employers. Thus, more than 4/5 of all needless costs to employers in dollars have not been for treating the diagnosed occupational disease; they resulted because the disease was not prevented (Table 17).

Seventy-two percent of all silicosis cases diagnosed or 435 cases have received compensation, 4/5 of them in the past 12 years (Table 18). The annual average compensation costs to the employers for silicosis have been $61,465.00 in the period 1935-1962; during the last 15 years the annual average was $105,061.00 and during the last seven years it was $142,066.00. This upward trend is understandable by recalling that over 55 percent of all silicosis cases have been diagnosed during this same period which at the same time included 83 percent of all the silicosis cases compensated. Such a build-up will not subside at once.

Beneficial By-product

Although set up for the pneumoconioses, the program has revealed considerably more cases of other types of pathology, mostly not previously recognized (Table 19 and Table 20). When each employee was alerted not only he and his family but his employer and community derived evident benefits because appropriate treatments could be sought. Personal physicians who would attend these patients are furnished, and benefit by, the official medical data after this is authorized by each individual concerned. In turn, we receive valuable and professionally gratifying follow-up reports from the physicians. Eighty-six percent of the pneumoconiosis cases diagnosed in the past 10 years were referred for vocational rehabilitation and one fifth of them entered profitable alternate work.

Awake to increasing pulmonary emphysema, even if not readily diagnosed, a study was begun which has revealed the startling ascent of emphysema as primary cause of death since 1949, a 16-fold increase in 14 years (Table 21). Further study of the data is anticipated in order to detect occupational aspects, if any.

The direct benefits of this program not only to employers [13-15] but also professions, and employees have been "documented" by several employers and others qualified to speak authoritatively.[16] Some employers have observed also beneficial by-products gained in reducing "strained backs" and other compensation problems,[13] mental depressions due to diagnosis of silicosis and other diseases,[15] possibility of prompt correction of serious disabilities not previously suspected, and the prevention of compensation claims based upon "heart attack", "chest pain", and others.

Comment

My major objective here has resulted from my assignment of a subject permitting wide latitude of presentation. A history of the North Carolina program has been presented; the statutory organizational and functional framework for its implementation have been discussed; some statistical data of the North Carolina State Board of Health and Industrial Commission have been summarized.

An effort has been made to appraise detected and possibly justified evidences of trends, some encouraging, others not yet so.

Much "polishing" of this first-time study is freely admitted to be necessary. Perhaps more useful results can be thus attained for others as well as selfishly for ourselves. We know of no other resource for such valuable basic data for the period covered.

REFERENCES

1. American Conference of Governmental Industrial Hygienists: Threshold Limit Values for 1964, Cincinnati, Published by the Conference, 1964.

2. Morris, J. W.: Workmen's Compensation: Its Philosophy and Application, N. C. Med. J., 25:155-159, (April, 1964).

3. Procedural Guide: Raleigh, Advisory Medical Committee, North Carolina Industrial Commission, December 10, 1962.

4. Meeting of Experts on the International Classification of Radiography of the Pneumoconioses, Extract from Occupational Health and Safety, IX:2, (April-June, 1959), Geneva, International Labour Office, 1959.

5. Dreesen, W.C., et al.: Pneumoconiosis Among Mica and Pegmatite Workers, Public Health Bull. 250, USPHS, 1940.

6. Easom, H.F., and Trice, M.F.: A Study of the Effects of Exposure to Dust in the Mining and Milling of Pyrophyllite, Raleigh, Division of Industrial Hygiene, North Carolina State Board of Health and Industrial Commission, February, 1939.

7. Russell, A. E., et al.: The Health of Workers in Dusty Trades: II Exposures to Siliceous Dust (granite industry), Public Health Bull. 187, 1929.

8. Dreesen, W. C.: Effects of Certain Silicate Dusts on the Lungs, Jour. Ind. Hyg., 15: 66-78, 1933.

9. Bloomfield, J. J., and Dreesen, W. C.: Silicosis Among Granite Quarries, Public Health Reports, 49: 679-684, 1934.

10. Middleton, E. L.: Industrial Pulmonary Disease Due to the Inhalation of Dust with Special Reference to Silicosis, Lancet, 231: 1-9, 59-64, 1936.

11. Dreesen, W. C., et al.: A Study of Asbestosis in the Asbestos Textile Industry, Public Health Bull. 241, 1938.

12. Sayers, R. R., and Jones, R. R.: Silicosis and Similar Dust Diseases: Medical Aspects and Control, Public Health Reports 53: 1453-1472, 1938.

13. Rogers, C. P., Jr.: Occupational Health and Accidents in Feldspar Mining, Arch. Env. H., 3: 42-45 (July, 1961).

14. Mitchell, J.: Health Progress in An Asbestos Textile Works, Arch. Env. H., 3: 37-41 (July, 1961).

15. Frank, J. P.: The Impact of Diagnosis of Silicosis, Arch. Env. H., 3: 34-35 (July, 1961).

16. North Carolina's Approach to Occupational Health, Arch. Env. H., 3: 1, (July, 1961).

TABLE 1

NORTH CAROLINA DUSTY TRADES PROGRAM
SIGNIFICANT STATUTORY ACTS

Responsibilities	Year of Act									
	1897	1919	1929	1931	1935	1937	1939	1955	1957	1959
Department of Labor	X	X	X	X			X			
Industrial Commission (Division of Workmen's Compensation)			X	X	X			X	X	
Insurance Commissioner			X							
State Board of Health					X				X	
Employers					X	X				
Employees					X					

TABLE 2

NORTH CAROLINA DUSTY TRADES PROGRAM
SUMMARY OF MAJOR STATUTORY RESPONSIBILITIES INVOLVED
1936 – 1963

FUNCTIONS/RESPONSIBLE AGENCY	Industrial Commission	Department Of Labor	State Board Of Health	Advisory Medical Committee	Employer	Employee	Vocational Rehabilitation
OCCUPATIONAL DISEASE STUDIES							
Dusty Trade Designated	X						
Employee Examination Required	X						
Work Place Survey Required	X						
Advisory Medical Committee Maintained	X						
WORKING CONDITIONS/WORK PLACES							
Standards (Rules & Regulations) Prescribed		X					
Health Standards Recommended			X				
Safety/Work Conditions Inspected		X					
Occupational Health Hazards Evaluated			X				
Results Reported To	X	X		X	X		
COMPENSATION STATUS ESTABLISHED							
Physical Examination Conducted				X			
Employee Health Status Reported By				X			
Employee Health Status Reported To	X				X	X	X
ENFORCEMENT							
Prescribed Standards		X					
Rules and Regulations		X					
COMPLIANCE							
Meeting Standards					X		
Providing Physical Examinations	X			X	X		
Factual Employment History						X	
Factual Health History						X	
Cooperating in Examination						X	
Prompt "Injury" Reporting					X	X	
Providing Medical Costs					X		
Accepting Feasible Rehabilitation						X	
Accepting Medical Care						X	
Providing Compensation					X		

TABLE 3

SILICOSIS IN NORTH CAROLINA
1935 – 1963*

Year	Number Cases First Diagnosed	Total Number Compensated Cases	No. X-ray Films (Chest) Dusty Trades
1935	1		505
1936	40		2,423
1937	26	2	2,744
1938	17	3	2,175
1939	3	4	1,651
1940	11	0	2,522
1941	31	10	2,567
1942	40	1	2,888
1943	29	3	1,372
1944	12	6	1,467
1945	25	13	2,655
1946	14	19	1,080
1947	9	14	429
1948	9	3	1,136
1949	17	11	1,496
1950	56	15	3,843
1951	32	43	4,645
1952	27	27	3,250
1953	26	31	2,812
1954	15	5	3,368
1955	26	22	4,665
1956	21	41	8,303
1957	18	10	8,394
1958	13	12	7,221
1959	23	21	8,292
1960	24	47	9,181
1961	17	36	6,678
1962	13	36	6,798
1963	8		6,309
	603	435	110,869

*"Number Cases First Diagnosed" and "No. X-Ray Films (Chest) Dusty Trades" are for calendar years from records of the Occupational Health Section, North Carolina State Board of Health; "Total Number Compensated Cases" from fiscal year data, North Carolina Industrial Commission Biennial Reports.

TABLE 4

NORTH CAROLINA STATE BOARD OF HEALTH
SUMMARY OF DUSTY TRADE ACTIVITIES
OCCUPATIONAL HEALTH SECTION

1954 – 1963

Year	No. Plants Surveyed By Engineers	Total Chest X-ray Films Examined	Retakes And Sanitorium Referrals Pending	Rejects	Work Cards Issued
1954	199	4,688	26	40	4,622
1955	---*	5,369	44	23	5,302
1956	22	5,815	199	32	5,584
1957	53	5,903	29	35	5,839
1958	270	4,637	88	31	4,518
1959	302	5,066	56	32	4,978
1960	242	6,787	110	36	6,641
1961	199	7,671	125	24	7,522
1962	218	7,598	80	22	7,455
1963	216	6,916	127	25	6,472

*Engineering services were interrupted during 1955 due to unforeseeable circumstances.

TABLE 5

NORTH CAROLINA STATE BOARD OF HEALTH
IDENTIFIED PNEUMOCONIOSIS CASES
OCCUPATIONAL HEALTH SECTION

1947 – 1963

DISEASE AND TYPE OF INDUSTRY	17-YEAR TOTAL
ASBESTOSIS	
Asbestos Textile	29
SILICOSIS	
Quarry	81
Mica	57
Feldspar	50
Monumental Stone	48
Foundry	28
Tungsten	23
Kaolin	20
Pyprophyllite	22
Talc	10
Construction	10
Spodumene	2
Quartz	2
Copper	1
Glass	1
TOTAL ASBESTOSIS	29
TOTAL SILICOSIS	355

TABLE 6

NORTH CAROLINA DUSTY TRADES PROGRAM
AVERAGE AGE IN YEARS AT INITIAL DIAGNOSIS
1935 – 1963*

Year	Stage of Silicosis S-I	S-II	S-III	Total
1954	47.6	46.9	None	47.1
1955	50.6	45.0	61.5	49.3
1956	50.4	55.4	None	50.3
1957	50.4	53.4	57.5	52.6
1958	50.0	55.6	None	51.4
1959	50.0	52.7	66.6	52.5
1960	52.3	58.4	44.7	53.5
1961	50.4	54.0	60.5	52.0
1962	48.0	None	None	48.0
1963	52.9	None	None	52.9
Total	50.2	50.9	57.75	50.0

*Initially diagnosed by the Advisory Medical Committee, North Carolina Industrial Commission.

TABLE 7

NORTH CAROLINA DUSTY TRADES PROGRAM
SILICOSIS CASES DIAGNOSED
1935 – 1963*

Number of Total Cases Per Employer	Total Cases	Number Employers With 1 to 29 Cases By Grade SI	SII	SIII
Ten or Fewer (184 employers)	371	108	90	47
Eleven or More (10 employers)	218	10	10	10
(194 employers)	589	118	100	57

*Initially diagnosed by the Advisory Medical Committee, North Carolina Industrial Commission.

TABLE 8

NORTH CAROLINA DUSTY TRADES PROGRAM
SILICOSIS CASES DIAGNOSED
1935 – 1963

EMPLOYERS WITH TEN OR FEWER TOTAL CASES OF ALL GRADES

Employers' Total Numbers of Cases	Number of Employers (By Grade)				Total Cases
	S-I	S-II	S-III		
One Case – only one grade	59	42	20		121
Two Cases (28 employers)					56
One case per grade	17	11	6	(34)	
Two cases per grade	6	5	-	(22)	
Three Cases (8 employers)					24
One case per grade	3	2	1	(6)	
Two cases per grade	3	2	1	(12)	
Three cases per grade	2	-	-	(6)	
Four Cases (7 employers)					28
One case per grade	1	5	3	(9)	
Two cases per grade	2	1	-	(6)	
Three cases per grade	2	-	1	(9)	
Four cases – one grade	1	-	-	(4)	
Five Cases (6 employers)					30
One case per grade	-	5	2	(7)	
Two cases per grade	2	1	2	(10)	
Three cases per grade	3	-	-	(9)	
Four cases per grade	1	-	-	(4)	
Six Cases (4 employers)					24
One case per grade	1	-	3	(4)	
Two cases per grade	-	4	-	(8)	
Three cases per grade	3	-	1	(12)	
Seven Cases (1 employer)	3	3	1	(7)	7
Eight Cases (2 employers)					16
One case per grade	-	-	3	(3)	
Two cases per grade	-	-	-	(0)	
Three cases per grade	-	1	-	(3)	
Four cases per grade	2	1	-	(12)	
Nine Cases (5 employers)					45
One case per grade	-	-	3	(3)	
Two cases per grade	-	-	1	(2)	
Three cases per grade	1	2	-	(9)	
Four cases per grade	3	1	-	(16)	
Five cases per grade	1	2	-	(15)	
Ten Cases (2 employers)					20
One case per grade	-	-	1	(1)	
Three cases per grade	-	2	-	(6)	
Six cases per grade	1	-	-	(6)	
Seven cases per grade	1	-	-	(7)	
184 Employers	108	90	47		371

TABLE 9

NORTH CAROLINA DUSTY TRADES PROGRAM
SILICOSIS CASES DIAGNOSED
1935 – 1963
EMPLOYERS WITH ELEVEN OR MORE TOTAL CASES OF ALL GRADES

Employer's Total Numbers of Cases By Grade	S-I	S-II	S-III	Total Cases
Eleven Cases (one employer)	3	5	3	11
Thirteen Cases (one employer)	5	5	3	13
Fourteen Cases (one employer)	9	2	3	14
Sixteen Cases (one employer)	13	2	1	16
Eighteen Cases (one employer)	9	7	2	18
Nineteen Cases (one employer)	8	10	1	19
Twenty Cases (one employer)	10	9	1	20
Twenty-four Cases (one employer)	10	12	2	24
Thirty-seven Cases (one employer)	21	10	6	37
Forty-six Cases (one employer)	29	11	6	46
10 Employers	127	73	28	218

TABLE 10

NORTH CAROLINA DUSTY TRADES
CASES DIAGNOSED
1935 – 1963 (a)

Number of Cases	Total	Stage/Grade/Category		
		I	II	III
Asbestosis	172 (b)	112	46	14
Silicosis	603 (c)	309	202	88
Total	775	421	248	102

Notes: (a) Initially diagnosed by Advisory Medical Committee, North Carolina Industrial Commission.

(b) Includes one case AI who was unemployed.

(c) Includes ten cases, three SI, two SII, five SIII, unidentifiable with a specific employer; one self-employed; three which could not be identified as even employed in a dusty trade.

TABLE 11

NORTH CAROLINA DUSTY TRADES PROGRAM
STAGES OF SILICOSIS DIAGNOSED (BY EMPLOYER)
1935 – 1963

Numbers of Cases In Grades Indicated	Numbers of Employers Having Silicosis Cases (By Grade)			
	S-I (a)	S-II (b)	S-III (c)	Total (d)
One Case	81	65	44	190
Two Cases	13	15	6	34
Three Cases	13	6	5	24
Four Cases	7	2	-	9
Five Cases	2	4	-	6
Six Cases	1	-	2	3
Seven Cases	1	1	-	2
Eight Cases	1	-	-	1
Nine Cases	2	1	-	3
Ten Cases	2	2	-	4
Eleven Cases	-	1	-	1
Twelve Cases	-	1	-	1
Thirteen Cases	1	-	-	1
Twenty-one Cases	1	-	-	1
Twenty-nine Cases	1	-	-	1
	126	98	57	194

Notes: (a) One hundred twenty-six employers have had from 1 to 29 S-I cases, each, with a total of 306.

(b) Ninty-eight employers have had from 1 to 12 S-II cases, each, with a total of 200.

(c) Fifty-seven employers have had from 1 to 6 S-III cases, each, with a total of 83.

(d) This column covers a total of 194 employers who have had 589 cases of Silicosis of all grades (i.e., some employers had one or more cases of all three grades).

TABLE 12

NORTH CAROLINA DUSTY TRADES PROGRAM
INDUSTRIAL HYGIENE SURVEY EFFECTIVENESS
1955 – 1964

Plant	Type of Industry And Department	MPPCF* Originally Found	MPPCF* After Recommended Correction Made
A	Talc Plant – Crayon Room	5 Machines – Average 50.0	Modify exhaust ventilation system – increase exhaust velocities – Average 11.0
B	Foundry – Stationary Grinders	Average 35.0	Exhaust ventilate grinders – Average 8.4
C	Foundry – Muller	Average 32.7	Improve exhaust ventilation system – Average 6.1
D	Refractories Mfg. (Pyrophyllite)	Batch Mix 323.3 Bagging Machine 105.8	Install exhaust ventilation system – Average 6.3 Average 10.2
E	Foundry	Riddle – Average 50.2	Exhaust or other control means – Average 3.4
F	Foundry	Stationary Grinder Average – 23.8	Repair duct work to grinder – Average 3.5
G	Ceramic Tile	Blending Machine – 175.6 Cleaning Operation Press No. 4 248.0	Modify exhaust hoods and branch duct – Average 6.3 Average 10.2
H	Foundry	Gen. Exposure Mold Room – 10.7	Install roof exhaust dilution ventilation fans – Average 2.8
I	Granite Quarry	Primary Crusher – 28.7	Install spray water system – Average 7.0
J	Granite Quarry	Primary Crusher – 59.8 Track Drill – 46.7	Install spray water system – Average 11.7 Install blower per design – Average 4.5
K	Granite Quarry	Primary Crusher – 34.0	Install spray water system – Average 12.0
L	Dimensional Granite Mfg.	Track Drill – 34.5	Provide blower per design – Average 7.0
M	Granite Memorials	Stone Cutter – 33.9 Stone Cutter – 15.2	Increase exhaust system – Average 6.4 Effeciency by installation of larger fan – Average 4.1

*Millions of particles per cubic foot of air, based on impinger samples counted by light-field technics

TABLE 13

NORTH CAROLINA DUSTY TRADES PROGRAM

INCIDENCE OF SIGNIFICANT PATHOLOGY ACCORDING TO LENGTH OF EXPOSURE TO PYROPHYLLITE - ONE FIRM

1936 – 1963

Length of Exposure in Years	Workers		Pathology	
	Number (a) (estimated)	%	Cases	%
Less than 2	40	54	4	10
2 – 4.99	18	24	12	66.6
5 – 9.99	8	11	5	62.5
10 – 19.99	9	11	15	100 (b)
20 and over			1	
Total	75	100	37	49.3 (c)

Notes: (a) Annual numbers of firm's employees unknown; numbers of employees in age groups exposed estimated upon basis of 75 employees known in 1963 and using group distribution found in 1936 detailed study.

(b) This figure obviously impossible but results when applying procedure of above.

(c) Obviously if pathology could continually be diagnosed consistently at rates of 1936 – 1945, this firm would have no employees to expose longer than 20 years.

TABLE 14

NORTH CAROLINA DUSTY TRADES

INCIDENCE OF SIGNIFICANT PATHOLOGY ACCORDING TO LENGTH OF EXPOSURE TO GRANITE QUARRYING – ONE FIRM

1935 – 1963

Length of Exposure In Years	Workers		Pathology	
	Number	%	Cases	%
Less than 2	Unknown		0	0
2 – 4.99			1	2.17
5 – 9.99			1	2.17
10 – 19.99			7	15.27
20 and over (19 over 30)			37	80.39*
Total			46	100.00

*Nineteen or 41.3% of all cases had over 30 years' exposure.

TABLE 15

NORTH CAROLINA DUSTY TRADES PROGRAM

EFFECTS OF PREVENTIVE MEASURES EXPRESSED IN AVERAGE AGES AT DIAGNOSIS OF SILICOSIS

1935 – 1963

Period/Grade		Example A (a) Good Effort	Example B (b) Bad Effort	Total Cases
1935–1963	Total	49.3	39.5	50 (c)
	S I	52.6	37.1	?
	S II	48.0	43.7	?
	S III	48.0	40.5	?
1954–1963	Total	57.5	36	50
	S I	56.1	35.7	50
	S II	63.7	37.0	51
	S III	57.0	None	58

Notes: (a) Example A is a granite quarrying firm with employee/case ratio of 15.33

(b) Example B is a pyrophyllite mining and milling firm with employee/case ratio of 49.3; another comparable firm's ratio is 28.

(c) Estimated

TABLE 16

SILICOSIS IN NORTH CAROLINA – COSTS

1935 – 1963*

Year	Total Compensation Paid	Total Medical Costs	Total Costs
1935			
1936			
1937	6,000.00	145.00	6,145.00
1938	264.00	201.00	465.00
1939	3,017.00	100.00	3,117.00
1940	0	0	0
1941	12,444.00	2,125.00	14,569.00
1942	2,500.00	0	2,500.00
1943	9,520.00	600.00	10.120.00
1944	19,558.00	1,614.00	21,172.00
1945	45,559.00	4,099.00	49,658.00
1946	31,480.00	2,546.00	34,026.00
1947	14,770.00	1,166.00	15,936.00
1948	11,300.00	30.00	11,330.00
1949	3,846.00	701.00	4,547.00
1950	70,638.00	1,740.00	72,378.00
1951	147,454.00	3,867.00	151,321.00
1952	113,195.00	1,135.00	114,330.00
1953	164,020.00	436.00	164,456.00
1954	20,550.00	0	20,550.00
1955	108,200.00	626.00	108,826.00
1956	84,327.00	277.00	84,604.00
1957	45,585.00	1,948.00	47,533.00
1958	63,192.00	2,156.00	65,348.00
1959	120,169.00	1,976.00	122,145.00
1960	252,098.00	2,955.00	255,053.00
1961	198,244.00	3,986.00	202,230.00
1962	173,107.00	7,236.00	180,343.00
1963			
	1,721,037.00	41,665.00	1,762,702.00

*Fiscal year data from North Carolina Industrial Commission Biennial Reports

TABLE 17

SUMMARY

NORTH CAROLINA DUSTY TRADES COSTS TO EMPLOYERS (PERCENT)*

1935 – 1962

Period And Percent of Costs	Compensation Paid		Medical Costs Paid		Total Costs	
	Silicosis and Asbestosis	All Other Causes	Silicosis and Asbestosis	All Other Causes	Silicosis and Asbestosis	All Other Causes
1935 – 1947	56	44	14.9	85.1	46.5	53.5
1948 – 1955	76	24	5.5	94.5	65.0	35.0
1956 – 1962	85	15	9.0	91.0	71.0	29.0
1935 – 1962	79	21	8.7	91.3	65.0	35.0

*Calculated from data included in North Carolina Industrial Commission Biennial Reports

TABLE 18

SUMMARY

NORTH CAROLINA DUSTY TRADES OCCUPATIONAL DISEASE WORK*

1935 – 1963

	Average Annual Number Cases Diagnosed			Number Cases Compensated			Percent Diagnosed Cases Compensated
	Total	1935–1948	1949–1963	Total	1935–1948	1949–1962	
Asbestosis	5.9	10.77	1.73	36	6	30	22
Silicosis	21.5	19	22	435	89	346	72
Total	26.4	28.9	24.1	471	95	376	61.4

	Average Annual $ Cost Of Compensation			Average Total Per Case Compensated	$ Costs To Employers	
	Total	1948–1955	1956–1962		Per Year	Per Cases Diagnosed
Asbestosis	5,280	12,079	6,990	1,446	5,431	927
Silicosis	61,465	101,198	142,066	4,052	62,954	2,923
Total	66,745	113,277	149,056	4,065	66,026	2,496

*The detailed activities involved in effective performance of this work (G.S. 130–11 (5)), implemented for the North Carolina Industrial Commission, were clearly defined for the first time in "Procedural Guide – The Advisory Medical Committee, North Carolina Industrial Commission, December 10, 1962," approved for distribution by the Commission's Chairman and the State Health Director.

TABLE 19

NORTH CAROLINA STATE BOARD OF HEALTH
SUMMARY OF DUSTY TRADE ACTIVITIES
OCCUPATIONAL HEALTH SECTION

1954 – 1963

Year	Diagnosed		Other Pathology	Referred to Voc. Rehabilitation	No. Rehabilitated to Profitable Alternate Work
	Silicosis	Asbestosis			
1954	16	1	-	-	-
1955	26	0	-	-	-
1956*	21	0	35	10	2
1957	17	1	21	25	8
1958	13	4	32	19	4
1959	23	0	23	25	4
1960	24	5	46	36	4
1961	17	1	32	16	4
1962	13	4	38	15	2
1963**	8	0	48	22	5
Total	178	16	275	168	33

* 1956 – Inclusion of other pathology in annual reports and Vocational Rehabilitation Program both begun in 1956.

**1963 – Of the 8 Silicosis cases diagnosed in 1963, the longest reported exposure was 50 years and the shortest was 13 years.

TABLE 20

NORTH CAROLINA STATE BOARD OF HEALTH
DIAGNOSED PATHOLOGY OTHER THAN PNEUMOCONIOSES
OCCUPATIONAL HEALTH SECTION

1956 – 1963

	1956	1957	1958	1959	1960	1961	1962	1963	Total (8 Years)
Heart	23	6	17	15	29	26	21	25	162
Pneumothorax	1	0	0	0	0	0	0	0	1
Cyst	1	0	0	0	0	1	1	0	3
Tuberculosis	5	6	6	4	6	0	4	2	33
Cancer	2	0	1	0	2	0	0	1	6
Pneumonitis	1	1	0	0	1	0	9	6	18
Bronchiectasis	1	1	1	0	1	1	1	0	6
Pulmonary emphysema	1	0	1	1	0	0	0	3	6
Tumor	0	3	1	0	0	3	1	4	12
Boeck's sarcoid	0	1	0	0	0	0	0	0	1
Lung disease etiology undetermined	0	1	4	2	5	0	0	6	18
Myocardial disease, chronic nephritis & cardiovascular	0	1	0	0	0	0	0	0	1
Silicotuberculosis & endobronchial TB	0	1	0	0	0	0	0	0	1
Pleurisy	0	0	1	0	2	0	1	1	5
Asthma	0	0	0	1	0	0	0	0	1
Histoplasmosis	0	0	0	0	0	1	0	0	1
Total	35	21	32	23	46	32	38	48	275

TABLE 21

NORTH CAROLINA STATE BOARD OF HEALTH
OCCUPATIONAL HEALTH SECTION

RESIDENT DEATHS DUE TO EMPHYSEMA*
IN
NORTH CAROLINA (CALENDAR YEAR)

1950 – 1963

Year	Number
1950	16
1951	14
1952	26
1953	35 (2x)
1954	37
1955	54 (3x)
1956	51
1957	67 (4x)
1958	72
1959	81 (5x)
1960	125
1961	131 (8x)
1962	184 (11x)
1963	254 (16x)

*International Statistical Code (5271)

Source: Public Health Statistics Section

TABLE 22

NORTH CAROLINA DUSTY TRADES PROGRAM

INCIDENCE OF SIGNIFICANT PATHOLOGY ACCORDING TO LENGTH OF EXPOSURE TO PYROPHYLLITE*

Length of Exposure	Underground				Surface			
	Workers		Pathology		Workers		Pathology	
	No.	%	Cases	%	No.	%	Cases	%
Less than 2 years	20	54	0	0	38	59	0	0
2 - 4.99 years	9	24	0	0	4	6	0	0
5 - 9.99 years	4	11	3	75	14	22	2	14.3
Over 10 years	4	11	4	100	8	13	6	75.0
	37	100	7		64	100	8	

The above tabulation brings out a most valuable disclosure. Note that the incidence of pathology, expressed in percentage, increases sharply with increasing length of service.

*Table 21 from A Study of the Effects of Exposure to Dust in the Mining and Milling of Pyrophyllite by H. F. Easom, M.D., and M. F. Trice: North Carolina State Board of Health and North Carolina Industrial Commission, Raleigh, 1939.

FIGURE I

NORTH CAROLINA DUSTY TRADES PROGRAM
PNEUMOCONIOSIS CASES DIAGNOSED

1935 – 1963

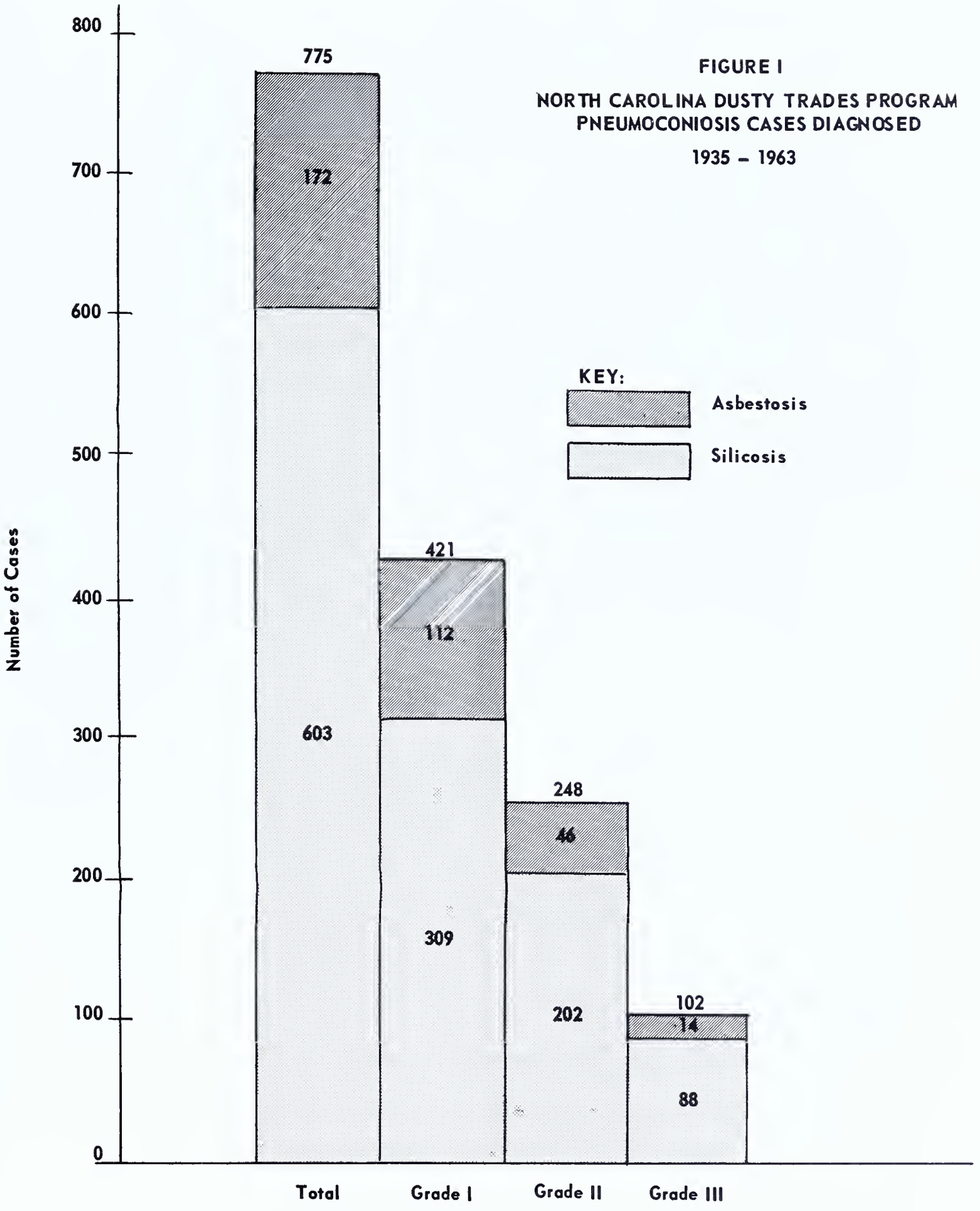


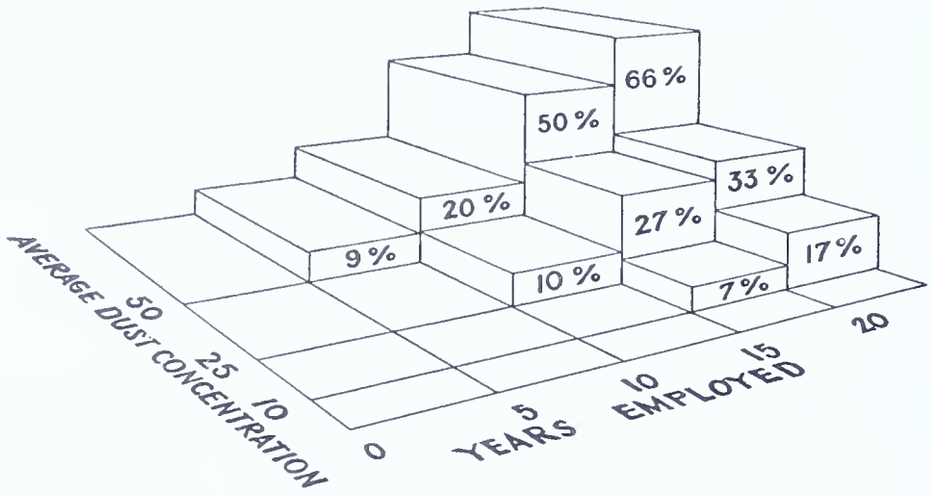
FIGURE II

NORTH CAROLINA DUSTY TRADES PROGRAM

PNEUMOCONIOSIS CASES OCCURRING AMONG 798 WORKERS EXPOSED TO MIXED DUST, CLASSIFIED BY AVERAGE DUST CONCENTRATION, LENGTH OF EMPLOYMENT, AND NUMBER OF WORKERS EXPOSED*

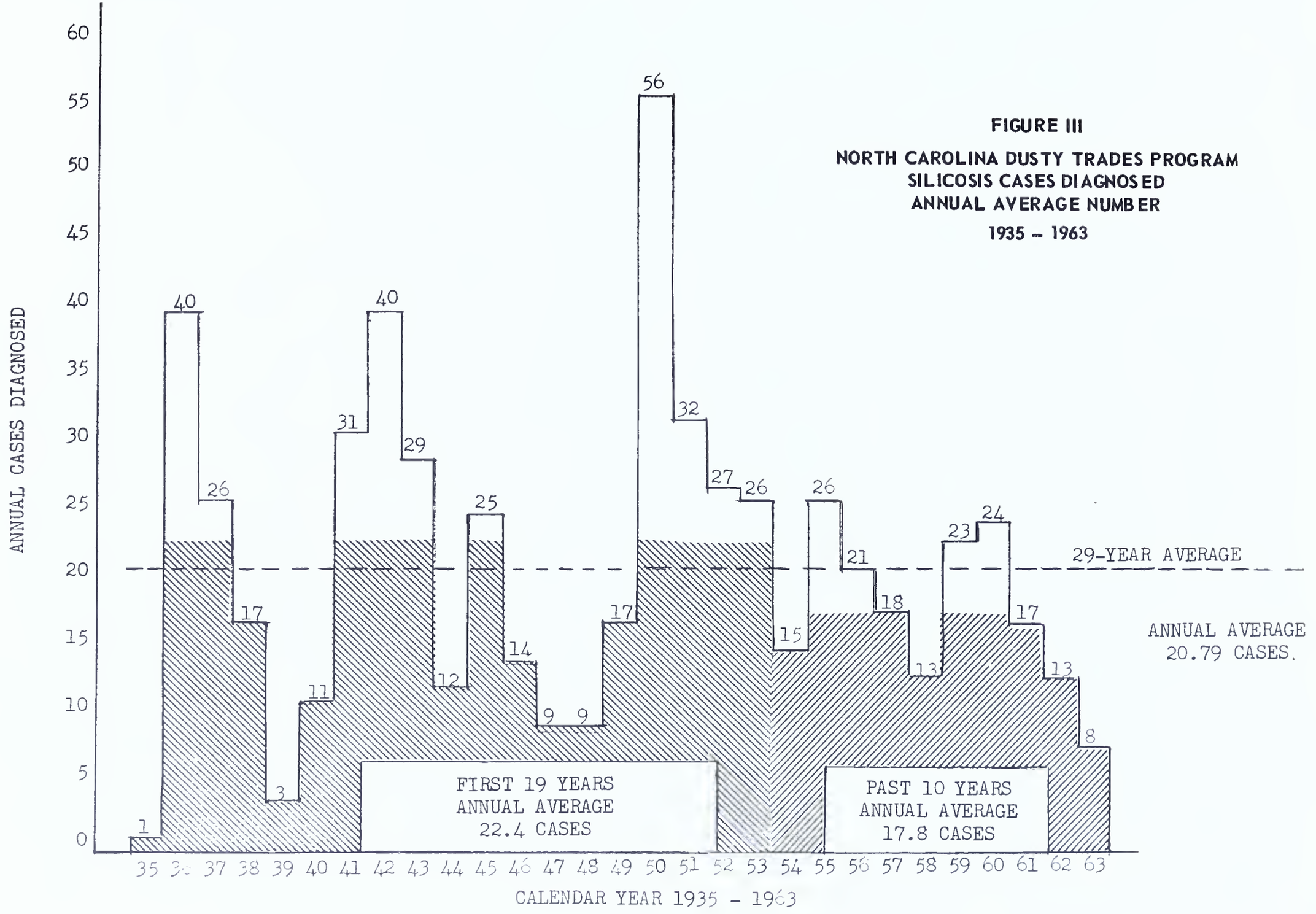
Average dust concentration (million particles per cubic foot)	Years in industry				
	0–4.9	5–9.9	10–14.9	15–19.9	20 and over
0–9:					
Number of pneumoconiosis cases	0	0	0	0	0
Number of workers exposed	81	56	29	13	8
Percent with pneumoconiosis	0%	0%	0%	0%	0%
10–24:					
Number of pneumoconiosis cases	0	0	0	2	4
Number of workers exposed	123	91	66	29	23
Percent with pneumoconiosis	0%	0%	0%	6.9%	17.4%
25–49:					
Number of pneumoconiosis cases	0	0	3	3	6
Number of workers exposed	43	45	31	11	18
Percent with pneumoconiosis	0%	0%	9.7%	27.3%	33.3%
50 and over:					
Number of pneumoconiosis cases	0	4	5	4	4
Number of workers exposed	45	44	25	8	6
Percent with pneumoconiosis	0%	9.1%	20.0%	50.0%	66.7%

[1] Includes the 57 mica-exposed men whose exposures are presented in table 15.
[2] Percentage values are shown graphically in figure 28.



Relation of Average Dust Concentration and Duration of Dust Exposure to the Percentage of Workers Found to Have Pneumoconiosis. Based on Data Presented in Accompanying Table.

* Table 18 and Figure 28 from *Pneumoconiosis Among Mica and Pegmatite Workers* by Waldeman C. Dreesen, J. M. Dalavalle, Thomas I. Edwards, R. R. Sayers, H. F. Eason, M.D., and M. F. Trice: Superintendent of Documents, United States Government Printing Office, Washington, 1940 (P. H. Bul. No. 250).


FIGURE III
NORTH CAROLINA DUSTY TRADES PROGRAM
SILICOSIS CASES DIAGNOSED
ANNUAL AVERAGE NUMBER
1935 - 1963
ANNUAL CASES DIAGNOSED
60
55
50
45
40
35
30
25
20
15
10
5
0
1 40 26 17 3 11 31 40 29 12 25 14 9 9 17 56 32 27 26 15 26 21 18 13 23 24 17 13 8
29-YEAR AVERAGE
ANNUAL AVERAGE
20.79 CASES.
FIRST 19 YEARS
ANNUAL AVERAGE
22.4 CASES
PAST 10 YEARS
ANNUAL AVERAGE
17.8 CASES
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63
CALENDAR YEAR 1935 - 1963

THE PNEUMOCONIOSIS PREVENTION PROGRAM IN THE METAL MINES OF ONTARIO

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Introduction

The Province of Ontario produces about one half of Canada's metallic and non-metallic minerals for a value of 876 million dollars annually. To do this the mines of the Province employ about 46,500 men, most of whom come in contact with dust produced from mining and milling operations, et cetera. From early records until the end of 1963, 1448 cases of silicosis had been recognized in Ontario, however, when you consider that only one tenth of these cases developed in the group of miners who commenced mining after January 1, 1929, one might wonder, why the difference. If we carry these statistics on further and see that to the end of 1963 only eight cases of silicosis have been recognized in men who entered mining after 1940, a period of twenty-three years, we might again ask, why? In that group there is only one man who did all his mining in Ontario. He worked seventeen years in various gold mines, three years in two uranium mines and then two more years in gold mines in Ontario. He did not take aluminum therapy until recently. Again we ask, why the drop? This seems to be a favorable trend, why should Ontario be the one to enjoy it?

History

Let us go back to the early stages of the recognition of silicosis. Actually the very first definite evidence of silicosis in men came from archeologist's discoveries in Egypt. It was here that they found well-preserved human remains of mummies in ancient tombs. Medical scientists examined the lungs of these mummies and found evidence of silicosis. These scientists conjectured that the building of the pyramids created a great deal of dust which was breathed by the Egyptian builders who in turn became silicotic. Agricola, who wrote about mining in Europe in the sixteenth century spoke about the "pestilential dust that rotted away miners' lungs."

Development of the rock drill during the last half of the nineteenth century helped bring the relationship of silicosis and dust to a head and paved the way for modern silicosis prevention measures. The first drill appeared in 1849 and it was followed through the years by improved versions. The first units were called piston drills, with the drill steel attached directly to the piston, and weighed over 300 pounds. The steel was solid and consequently, drilling was dry. It is reported that miners came home from work covered with rock dust and looking as though they had labored in flour mills.

In the South African Rand Gold Mines, some 1177 men were running dry drills in 1898. Just after the Boer War in 1903, 225 of the 1177 had died from lung disease. This appalling situation brought the silicosis problem to a head in South Africa. A Commission was established at this time, which made recommendations that led to a program that has been beneficial to the mining industry throughout the world. Some of the highlights of the South African program to prevent silicosis were as outlined below:

In 1911, X-ray surveys were conducted to determine the prevalence of silicosis in gold miners and silicosis was made compensable.

In 1916, X-ray examinations were required and miners' certificates issued.

In 1919, the wet Leyner type drills were required by law and the mines introduced ventilation practices as we know them to-day.

Recognition and Prevention in Ontario

Large scale mining in Ontario started at the time Leyner was perfecting his wet drill.

The Sudbury camp was founded in 1885, Cobalt in 1903, Porcupine in 1909, Kirkland Lake in 1914, Red Lake came later in 1924 and Blind River in 1953.

Early miners in our Province used hand steel and dry drills. In the gold quartz mines this brought about a silicosis situation. Fortunately it was recognized at an early date and a prevention program initiated.

The Workmen's Compensation Act of Ontario was passed in 1915 and miners' phthisis was added to the list of compensable industrial diseases in 1916. Under this provision of the Act an average of only two cases were compensated a year. In 1924 the Department of Public Health made a survey of miners in the four principal camps and the survey indicated that an alarming proportion of men exposed to dust had silicosis in one form or other of its several stages.

A number of conferences were held between the representatives of the Department of Mines, the Department of Public Health and the Workmen's Compensation Board and the Mine Operators. The Operators were advised that in the earliest stages of silicosis there was no physical disability, and that if men at that stage were removed from underground there would be little danger of permanent disability. They were further advised that if active steps were taken to clean up the situation, compensate those men who had some real disability, and remove from the mines those men in the early stages of silicosis, the first cost would be the greatest and from that time on their liability should decrease.

Changes in Statutes

The mines co-operated and amendments were made to the Workmen's Compensation Act, and the Mining Act in 1926. The amendments to the Mining Act provided that all underground employees must be the holders of certificates certifying that they were free from tuberculosis of the respiratory organs and further provide that the certificates must be renewed annually. The amendments to the Compensation Act defined both silicosis and tuberculosis and adopted the South African classification in its three stages of ante-primary, primary and secondary. The Workmen's Compensation Board definition of silicosis was written as follows:

"Silicosis means a fibrotic condition of the lungs, sufficient to produce lessened capacity for work, caused by the inhalation of silica dust."

The Mining Act designated what constituted "dust exposure occupations", and required certification of men engaged in these operations. The Compensation Act provided a means for the examination of men so engaged and the Board's officers issued the necessary certificates, in other words, the two Acts were complementary. The funds for the operation of the examination centres are part of the assessment made on the mining industry.

Mining Act Part IX 167 (1) (c)

"Dust exposure occupation" means: –

1. employment underground in a mine
2. employment on surface where ore or rock is crushed dry
3. employment at other locations as designated by chief engineer, e.g. grinding sections of Assay Offices.

Mining Act Part IX 167 (2 – 16)

The Miner's Certificate now in use is a certificate to the effect that the man in question is "free from tuberculosis of the respiratory organs". To keep a certificate in good standing a man must be examined (x-rayed) annually.

Certification is actually carried out in three stages: –

1. The initial certificate is issued after pre-employment examination and good for one year.
2. An endorsed certificate is issued after a second examination (one year) and good for one year.
3. The Miner's Certificate is issued after two years. Must be renewed each year by re-examination.

When issuing an initial certificate or endorsed certificate the medical officer must find the applicant free from disease of the respiratory organs and otherwise fit for employment in a dust exposure occupation.

When issuing the final Miner's Certificate, the medical officer must find the applicant free from tuberculosis.

In the early stages it was considered advisable for both the company and the employees that the men with silicosis be taken out of the mines. To ensure this, the Compensation Board in advising a man that he had been classified as silicotic, notified him that if he continued work in which he was exposed to silica dust he would not be entitled to any further compensation, irrespective of whether or not his disease progressed.

Awards

The award made for anteprimary, or first stage silicosis was $500. Because there was believed to be no physical disability with that stage of silicosis the award was not considered a compensation but as a rehabilitation allowance, to carry the man over the period of establishing himself in some other occupation.

The award for primary, or second stage silicosis, which implied some physical disability was $1000, and for secondary or complete disability, the regular award was $2000 per year.

A silicosis examining station was established in the Porcupine Camp, which is the location of Timmins, and the major gold producers in Ontario. At first this station was operated by the mines themselves, but subsequently, at the request of the Operators it was taken over by the Workmen's Compensation Board. Experience showed that early-stage silicosis did progress and as a result, although it was not apparent for some years, every anteprimary silicotic was considered as a potential total disability case, with an average estimated cost of $11,000. Eventually, when the award of $500 was made to an anteprimary, an additional progression liability of $10,500 was set up and the industry was asked to provide this sum as well. It also became apparent that there was little advantage in removing a known silicotic from his ordinary work as a careful analysis of progression rates indicated that little, if any, difference was in favor of those removed. That decision was subject to the qualifications that every effort would be made to reduce the dust hazard, and that silicotic men should not be allowed to work where dust concentration was high.

The problem of tuberculosis was recognized although tuberculosis was not itself a compensable disease, but tuberculosis with any stage of silicosis was considered a total disability. Silicosis predisposes a man to tuberculosis, and as the Ontario Act was interpreted, the development of tuberculosis in a silicotic was considered as a result of the silicosis and as such was compensable. It did not make any difference under what conditions or how many years after a silicotic left the industry. If tuberculosis developed the industry was held liable. In effect, industry was required to provide insurance against the development of tuberculosis in a silicotic as long as the man lived. These conditions were not acceptable to anyone as they were difficult to administer, and further admendments were introduced to the Workmen's Compensation Act in 1933. Briefly they provided that the old classification in three stages be eliminated and, of course, with it went the lump sums for anteprimary and primary cases. While not provided for in the Act, it was also agreed that men in the early stages of silicosis should be allowed to continue in their ordinary occupation, provided there was no tuberculosis or even a reasonable suspicion of tuberculosis. The amendments provided that the industry would be responsible for increased disability as a result of progression. In uncomplicated cases it would not be responsible for increased disability as a result of T.B., unless the T.B. developed within two years from the time of leaving employment.

In 1943, the Act was amended to provide for an increase in the maximum earnings on which compensation is calculated from $2000 to $2500 with a maximum payment of two-thirds average earnings for total disability.

In 1960, the Act was amended to provide for an increase in the maximum earnings, on which compensation is calculated, to $6000 with a maximum payment of 75% of average earnings for total disability.

Time Limits

A summary of the changes in time limit for claims under the Workmen's Compensation Act, bringing it up to date is as follows:

"Any workman who has heretofore ceased, or may hereafter cease to be usually and regularly employed in an industry under this Act in which he was exposed to silica dust shall make and establish his claim of disability therefrom within--"

1926	the claim had to be established while working
By 1933	two years after leaving
By 1937	three years after leaving
By 1939	five years after leaving
From 1943 on	no time limit

The total exposure required to establish a claim in 1926 was at least five years in Ontario Mines, exposed to silica dust. A later amendment has reduced that to at least two years in Ontario Mines exposed to silica dust.

Silicosis Assessments

Originally, for the purpose of silicosis assessments only, the mines of the Province were divided into five groups.

1. Porcupine
2. Kirkland Lake
3. Sudbury
4. Silver Mines
5. All Other Mines

Each group bore the cost of the silicosis charged against the mines of the group. Costs were estimated by the Board and a flat rate per dust shift worked established. Assessments to the individual mines were based on this rate. Dust shifts were defined as the shifts worked by all underground men, by men employed in dry crusher plants on surface, and by men employed in the grinding sections of assay offices.

Currently, for the purpose of assessments for silicosis and other pneumoconioses, the Industry is divided into ten groups.

1. Asbestos
2. Gold
3. Iron
4. Nepheline syenite
5. Nickel
6. Uranium
7. All Other Mines
8. Diamond Drilling as a Business
9. Shaft Sinking as a Business
10. Reduction of Ores as a Business (Not Including Iron)

Each group bears the cost of the silicosis charged against the mines of the group.

The assessment is based on past year's experience and rate calculated as a percentage of total payroll.

Assessment for the Gold Group 1964 is $3.50 per $100 payroll. The money collected is funded to capitalize payments for claims which have been estimated to cost $25,000 per man on the average to date.

A summary of the historical highlights is set out below and in it you will see reference to the formation of a silicosis research committee of the Ontario Mining Association, or the Committee on Silicosis. This Committee essentially provides the liason between the mines and the Province and other research groups attempting to ensure that no stone is left unturned in the fight against silicosis, and that continuity of early programs is maintained.

Engineering Controls

The Ontario Mining Association, in 1934, set up a Technical Silicosis Research Committee which, in 1943, was superseded by the Committee on Silicosis (COS) of the Mines Accident Prevention Association of Ontario and recently (1964) renamed Committee on Occupational Health.

These committees devoted their time to studying and solving problems related to silicosis. They promoted, and the mines adopted, improvements in dust control, ventilation, working conditions, et cetera.

The latest programs, sponsored by the Committee, have been:

1. The development of standard codes and reporting of dust and ventilation surveys. The results of these surveys are processed by the Committee, with comparisons of the dust hazard for the various operations at the various mines compared. These surveys are providing a healthy stimulus to better ventilation and dust control.

2. A great deal of stimulus towards better silicosis prevention is also developed by the ventilation groups that have been formed in the various Camps. Ventilation Engineers compare dust counts at these meetings and thus assure industry that accurate and comparable data are being collected. Of perhaps greater importance is the exchange of data on improved methods which cannot help but lessen the silicosis hazard in our mines.

Aluminum Therapy

Soon after research started on improving engineering controls, it became recognized that ventilation and dust control measures would not entirely prevent exposure to silicosis-producing dust of "all miners, at all places, at all times" that some harmful dust would enter the lungs.

With this in mind, the McIntyre Porcupine Mines sponsored a research program which, in collaboration with the Sir Frederick Banting Institute, developed a method of reducing the toxicity of silica in the lungs. This method, which is known as aluminum therapy came into practical use in Canadian mines, having a silicosis problem, in the years 1944-45. Later its use spread to other countries, notably Mexico and Western Australia.

McIntyre Research Foundation stress the fact that Aluminum Therapy should only be considered as an adjunct to other methods of control. Under no consideration should it replace medical and engineering controls or be regarded as a "cure" for silicosis.

Paterson Report

Reference should be made to the Paterson Report which is a very thorough study made by an independent, well-qualified doctor at the request of the Ontario Government. The recommendations tended to confirm work that had been done to date with respect to examinations. A copy of this report can be obtained from the Province of Ontario - Bulletin 158 - The Ontario Department of Mines, entitled "Silicosis in Hardrock Miners in Ontario", by Dr. John F. Paterson. The report is very detailed and the recommendations are full and complete, both from a medical and a mining point of view. However, I will highlight a few of the major recommendations which have been implemented.

1. Employment of persons without proper certificate constitutes a liability to the whole industry, and for this reason, exceptions to the rules continued in Section 167 of the Mining Act should be reduced to a minimum.

2. Mines served by mobile chest examination services of the Workmen's Compensation Board, or by other chest examination services, do have problems. Nevertheless, it is advisable that mines so served do not permit an applicant to start work in a dust exposure occupation until his initial or miner's certificate has been received.

3. Chest x-ray films of 14 x 17 should continue to be used throughout the industry. Miniature chest x-ray films should not be reintroduced.

4. The importance of an early detection and treatment of tuberculosis in new employees and miners, is recognized. This disease is the chief cause of disability in silicotics and an important cause of their deaths.

5. The employers should ensure that a record of the occupation of, and aluminum prophylaxis used by the holder of a certificate, should be entered on Page 4 of the certificate prior to the annual chest x-ray and at the time of leaving employment.

6. Dr. Paterson recommends that a code of requirements for periodic surveys of dust and ventilation should be issued by the Ontario Department of Mines to all mines in which the free silica content of aerial dust exceeds 10 per cent. These surveys should be required at intervals of not more than 6 months where there is no radiation hazard, and the records should be available to the engineers of the Ontario Department of Mines.

   The Committee agreed with the making and recording of periodic dust surveys, but recommended that the practice of semi-annual surveys be continued on a voluntary basis and that the surveys be done by each mine regardless of the free silica content of the dust in the mine. The Committee emphasized the necessity of continued sampling to discoved bad spots and to correct them.

7. Dr. Paterson stated: "More analyses of aerial dust collected by long-period dust sampling instruments are required. Dust is measured by the Konimeter, and high counts are rightly believed to indicate bad mining practice, but in estimating the danger to health, there should be more emphasis on the proportion of free silica in the aerial dust."

   The Committee agreed that investigations of the free silica content of the dust be expanded. It also believes that the finding of a low silica content in mine air should not curtail programs of dust surveys in that mine. The Committee further suggests that at least two samples of aerial dust be collected and assayed for quartz and total silica and the results reported with the semi-annual surveys. Procedures for the proper taking and assaying of samples may be had from the Committee's engineers.

8. More emphasis should be placed on delivering fresh air to the place where employees are working. The measurement of fan capacity in cubic feet per minute is no measure of silicosis control unless it is a measurement of fresh air flowing to the miners.

9. The Committee agrees that "tuberculosis control of the non-mining members of mining communities by routine examination of employees not exposed to dust and by community chest x-ray and tuberculin surveys should be continued."

   The Committee recognized the need for continued interest in the promotion of chest x-rays and tuberculin surveys of the lay population. These surveys, which are conducted by the Ontario Department of Health usually in co-operation with local service organizations, should be rotated campwise and on a scheduled basis. Employers should take an active part in furthering these surveys.

10. Since so much effort is devoted to preventing contact with active pulmonary tuberculosis, a miner requiring investigation of his pulmonary disease in an institution should be admitted to a tuberculosis sanatorium only if beyond all reasonable doubt he has active tuberculosis. Otherwise, he should be admitted for investigation to a general hospital.

11. Dr. Paterson stated: "Finally it should be remembered that the decrease in the problem of silicosis in hardrock miners in Ontario since 1926 is chiefly due to the efforts which have been made to prevent it. The human lung has changed little since 1926, and free silica dust is as toxic now as it was then. If the decrease in the problem of silicosis leads to a decrease in the awareness of the danger, it is possible that the encouraging trends may be reversed. Continuing education of management and labor in their responsibilities in prevention needs continuing emphasis."

Historical Highlights in Summary

1. 1916 Miners' Phthisis was added to the list of compensable industrial diseases. Workmen's Compensation Act.

2. 1924-25 Department of Health surveys to determine incidence of silicosis in gold mines.

3. 1926 Silicosis made compensable.

4. 1929 Pre-employment and annual x-ray examinations established. Silicosis Referee Board appointed.

5. 1932 Start of research with Sir Frederick Banting of the U. of T. McIntyre Porcupine Mines plays leading role.

6. 1934 Technical Silicosis Research Committee appointed by Ontario Mining Association.

7. 1944-45 Prophylactic use of aluminum powder in change rooms introduced. T.S.R.C. superseded by the Committee on Silicosis (COS) of the Mines Accident Prevention Association of Ontario.

8. 1950 Medical Statistics Unit formed under Workmen's Compensation Board.

9. 1959 Paterson Report: "Silicosis in Hardrock Miners in Ontario."

10. 1962 Semi-annual dust and ventilation surveys started. Ventilation groups formed in mining centres.

Note: In 1964 Committee on Silicosis renamed Committee on Occupational Health.

Results

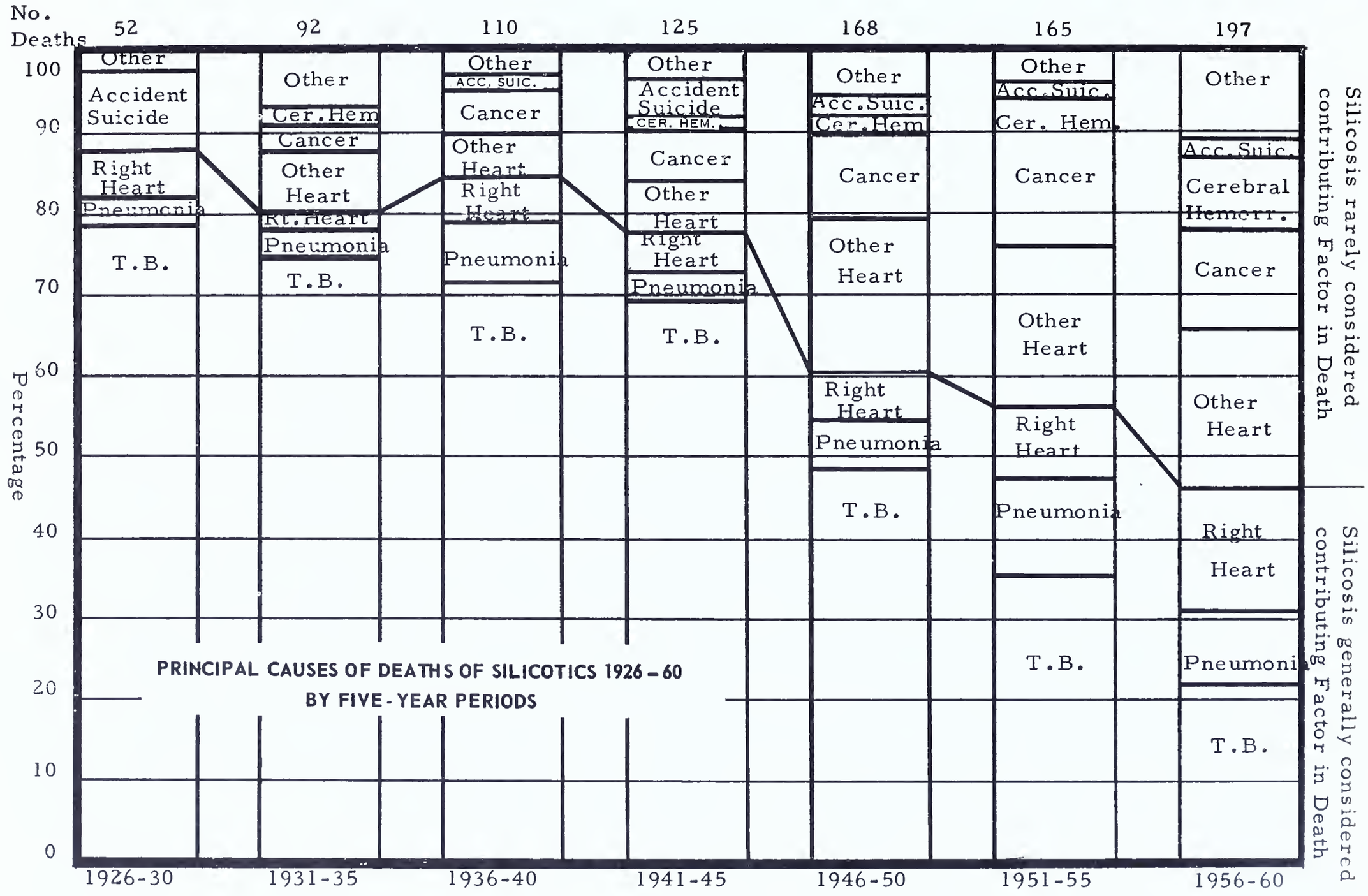
Now what have the results been to date? Needless to say, over the years, we have come up with many ways of indicating our performance. Recent studies on statistics have been based on cohorts, or groups of miners by periods. For the purpose of this meeting and not to burden you with more figures than you already have, the attached graph indicates the cumulative number of silicosis cases for each cohort, plotted against elapsed time. Cohorts fall into three distinct groups, each succeeding group showing characteristics common to that group and with much improvement over preceding groups. The first group is the pre-1930, or pre-x-ray. They have by far the highest incidence. The 1930 - 44 group experiences a consistent and lower incidence and the post 1945 group has a very low incidence and is practically statistically indeterminate. The graph covers all silicosis cases for Ontario.

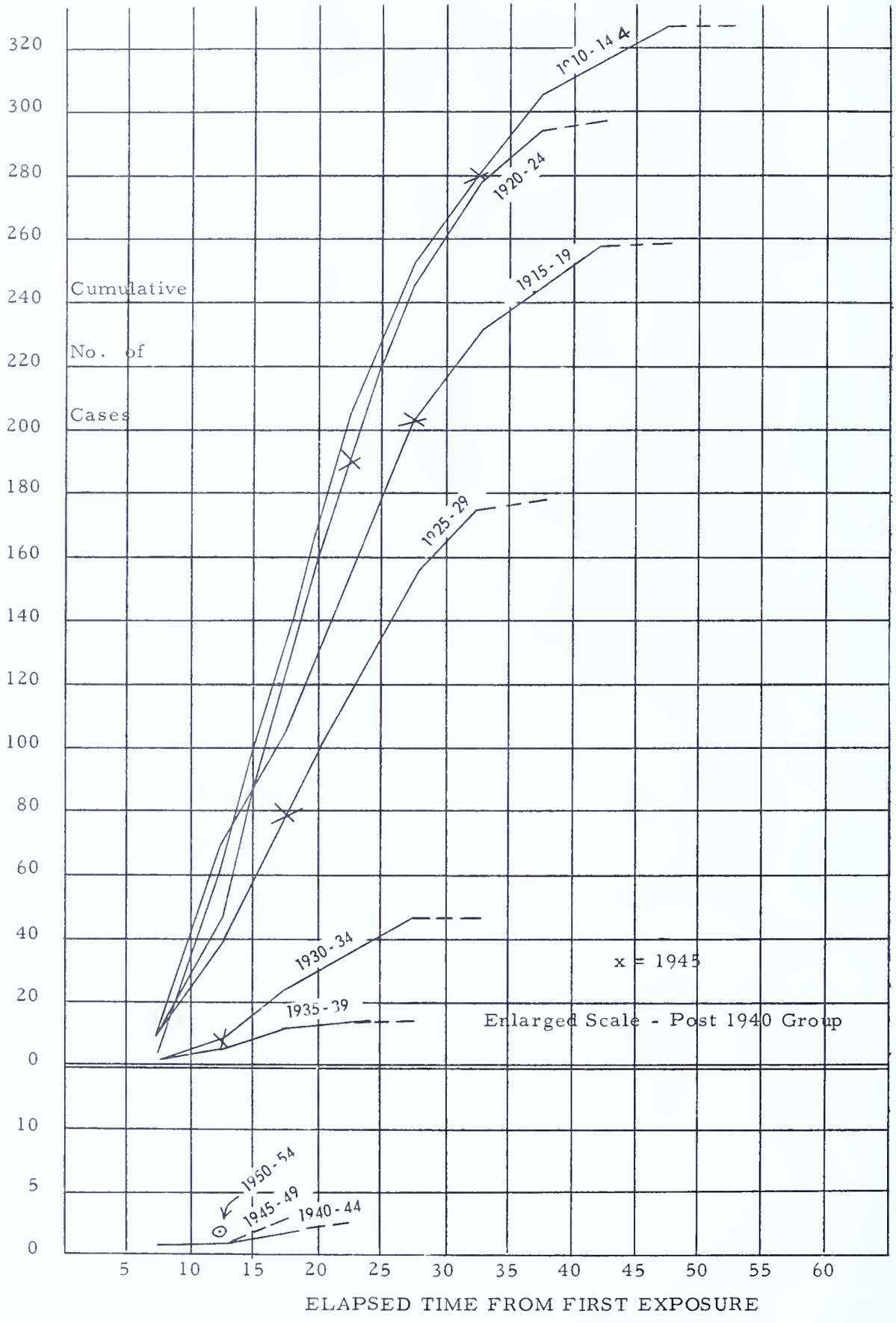
Another significant chart showing the trend of the impact of tuberculosis on persons suffering from silicosis is attached. As the program continues silicosis occurrence has less and less liability in deaths.

In summary our program to examine, closely and carefully, each miner engaged in mining in our Province at least annually, and the great emphasis on provision of fresh air, and the reduction of air-borne dust, with the necessary controls to see that this is being done are the main measures currently in effect. The use of aluminum therapy and its results are still in the experimental stage and no further comments on its benefits are warranted at this time.

Summary

In the Province of Ontario production from metallic and non-metallic minerals amounted to 876 million dollars in 1963. About 46,500 men were employed in the industries producing this mineral wealth. Of the total of 1448 cases of silicosis recorded in the Province, approximately one tenth commenced mining in Ontario after January 1, 1929. Since 1944 only one new case has developed in the group who commenced and continued mining in Ontario alone. This paper has reviewed the simple step-by-step procedure adopted by the mines of Ontario and the Provincial Government to combat the development and progression of silicosis. Basically the program has been to give the miners the best yearly medical examination and the cleanest air possible. These steps have to be very carefully controlled and it is the development of the control of these measures and the observation of the effectiveness over the years that provides our story.


No. Deaths
52
92
110
125
168
165
197
100
90
80
70
60
50
40
30
20
10
0
Percentage
Other
Accident Suicide
Right Heart
Pneumonia
T.B.
Other
Cer.Hem
Cancer
Other Heart
Rt.Heart
Pneumonia
T.B.
Other
ACC. SUIC.
Cancer
Other Heart
Right Heart
Pneumonia
T.B.
Other
Accident Suicide
CER. HEM.
Cancer
Other Heart
Right Heart
Pneumonia
T.B.
Other
Acc.Suic.
Cer.Hem
Cancer
Other Heart
Right Heart
Pneumonia
T.B.
Other
Acc.Suic.
Cer. Hem.
Cancer
Other Heart
Right Heart
Pneumonia
T.B.
Other
Acc.Suic.
Cerebral Hemorr.
Cancer
Other Heart
Right Heart
Pneumonia
T.B.
1926-30
1931-35
1936-40
1941-45
1946-50
1951-55
1956-60
PRINCIPAL CAUSES OF DEATHS OF SILICOTICS 1926 – 60
BY FIVE-YEAR PERIODS
Silicosis rarely considered contributing Factor in Death
Silicosis generally considered contributing Factor in Death


320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
10
5
0
Cumulative
No. of
Cases
1910-14
1920-24
1915-19
1925-29
1930-34
1935-39
1950-54
1945-49
1940-44
x = 1945
Enlarged Scale - Post 1940 Group
5
10
15
20
25
30
35
40
45
50
55
60
ELAPSED TIME FROM FIRST EXPOSURE

COAL PNEUMOCONIOSIS AS A WORLD-WIDE PROBLEM

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Archeological findings indicate that man has been using coal for fuel and various other purposes for over 6,000 years. During the Middle Ages in England and France, coal came into common use as fuel, and there the problems began. The smoke and fumes were suspected of causing disease epidemics and Edward I in England ruled that anyone caught burning coal was subject to the death penalty.

Later in the 16th century, Georgius Agricola, in his famous treatise on mining—De Re Metallica—stressed the importance of preventive medicine in the mining industry, and warned that "Miners are sometimes killed by the pestilential air which they breathe; sometimes their lungs rot away." 1/

Four centuries later in the report of a study of the coal mines, Admiral Boone, the survey director, stated, "It has been evident to the members of the Medical Survey Group that industrial health has not received the required attention, nor kept pace with scientific industrial mechanization. Until the human element, which is of prime importance to the fullest utilization of the machine, is comparably brought into maximum strength and vitality and responsiveness, industrial mechanization cannot be developed to its fullest potential. In a short-sighted rush of speed to create and develop machines in the interest of wealth and greater comfort, the health of the people who operate those machines has been neglected or given too limited attention. With the advancement of mechanization, obviously there is a greater exaction on physical well-being and mental acuity. Health is not only man's most valuable possession but a necessary requisite to the progress of the mechanized age." 2/

Although the medical literature during the intervening four centuries is replete with warnings that coal miners suffer with an unusual chest disease, it was not until 1928 that the problem of chest diseases in bituminous coal miners began to receive public recognition. In this year Collins and Gilchrist published a paper on the "Effects of Dust on Coal Trimmers" 3/ which precipitated a long and detailed investigation of chest disease problems in the bituminous coal workers of Great Britain. Studies of the disease problem in Great Britain were initiated in 1936 by the Committee on Industrial Pulmonary Diseases of the Medical Research Council. During the intervening years many thousands of pounds have been spent by the British in studying the etiology, pathology, and prevention of coal pneumoconiosis. Despite this tremendous research effort, coal pneumoconiosis continues to be the most serious occupational disease problem in England. To gain some concept of the magnitude of the coal pneumoconiosis problem, this Division requested certain information from the Ministry of Pensions and National Insurance of Great Britain. Although it is not possible to accurately compile such statistics, the Ministry estimates that at the present time approximately 50,000 people in Great Britain are receiving disablement pensions for all types of pneumoconiosis at a total cost of over 23 million dollars a year under the Industrial Injuries Scheme. Although figures are not available on the amount of money being spent for research purposes, it is estimated that this approximates nine million dollars per year. Despite control programs placed in effect in the British coal mines, the Ministry of Pensions and National Insurance views the compensation problem as a long-term one of considerable magnitude.

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Although coal pneumoconiosis was recognized as a problem on the European continent about 1935, a coordinated effort was not made to study or prevent the disease until the European Coal and Steel Community was set up by the Treaty of Paris in August 1952. One of the aims of the Community is to provide for better health among the employees of the coal and steel industry. By 1962 it had allocated eight million dollars for research into industrial health and the prevention of accidents, but with particular emphasis on silicosis and other pneumoconioses. Coal workers' pneumoconiosis is recognized as a compensable disease in each of the European coal producing countries and in most, the compensation cost for coal pneumoconiosis is greater than all other occupational diseases combined. In some countries the cost of coal pneumoconiosis compensation begins to approach the cost of accidents. Through the research grant program of the European Coal and Steel Community, many excellent research laboratories have been developed in the European countries and the volume and the quantity of research emanating from these institutions is of the highest quality. The work of these laboratories has not only related to coal miners' pneumoconiosis, but has added much to fundamental knowledge of the pathology and physiology of the dust diseases. In fact, through this program and the supplementary efforts of the various European countries there are far more facilities in Europe for studying pneumoconiosis, bronchitis and emphysema, and the effect of dust on human health, than there are in the United States.

Preventive measures employed in European mines differ in detail from country to country, but have the common factor of environmental control and medical surveillance of the individual. Environmental control is based primarily upon dust suppression by water infusion of the coal face, water sprays during blasting, and sprays on all automatic hauling equipment. In addition, extensive use is made of ventilation, both general and auxiliary as a dust control device.

Instruments used for measuring dust concentrations vary from country to country, but most of the countries are gradually converting to a respirable mass standard. In Germany the Tyndallometer is still the instrument of choice, whereas, in Great Britain the thermal precipitator is the standard instrument, although many authorities in this country recommend converting to a respirable mass instrument. In other countries, a respirable mass instrument is being used, but the instrument varies between countries. In most countries, the responsibility for environmental control is vested in the mining company, and many have rather elaborate dust control programs. The dust concentration is usually categorized into three areas: safe, marginal, and unsafe. In practically all cases the standard is a function of the stone content and the concentration of the respirable dust of less than five microns. In France, Germany, Holland, Belgium, and Great Britain, there are extensive research programs, usually under the sponsorship of the government, in dust evaluation.

In all of the European countries, emphasis is placed on the medical control of the miner which includes pre-employment and annual periodic examinations. Once an individual develops early pneumoconiosis, medical practice requires that he be placed in an area of safe dust concentration. If the disease continues to progress, he is removed entirely from dust exposure. In at least one country, the miner is removed from the dusty environment as soon as he develops early pneumoconiosis.

In all of the member countries of the European Coal and Steel Community, the principle of partial disability due to coal pneumoconiosis is well accepted. However, the details of compensation vary from country to country. The German principle is portrayed as an example since most of the other countries have a similar but not identical pattern. Only workers with no roentgenologic evidence of silicosis or pnuemoconiosis are permitted to work in marginal or unsafe dust areas. When pneumoconiosis is first recognized on the radiograph, the worker is transferred to a so-called "safe-work area" or occupation. If this results in a decreased pay rate due to job classification, the worker is given an extra stipend so that he will suffer no loss in earnings. When his pneumoconiosis has progressed to a 21 percent disability which is determined by a rather complicated formula based upon loss of pulmonary function, then he is entitled to compensation, but he does not have to leave the mines. In other words, he draws compensation as well as his full wages. The formula used to calculate compensation is the worker's average wage at the time of his disablement times 0.8 multiplied by the percentage of disability. For example, a worker with 50 percent disability would receive 40 marks for every 100 marks of wages. A worker may request a revaluation

every two years or his physician may request it whenever in his opinion there has been a change in the worker's physical condition. If the worker has shown an improvement since his last evaluation, he must accept the lower rate. Throughout Europe, compensation for coal pneumoconiosis has become a major item in the cost of producing coal, and it is anticipated that compensation costs will continue to rise for several years. Doubtlessly, the high cost of compensation for coal pneumoconiosis is one of the factors which prevents European coal from being competitive in cost with American coal when delivered to the major European ports.

Although an attempt has been made to summarize the European experience, the conclusions of the authors may not necessarily parallel the concepts of other investigators. On some points, there is not total agreement between investigators and where these exist, the conclusion given is generally based on predominant opinion.

(1) Coal pneumoconiosis is a distinct clinical entity, resulting from inhalation of coal dust. The clinical diagnosis is based on radiologic evidence of nodulation with a history of exposure to coal dust. Coal pneumoconiosis is classified into two forms: Simple pneumoconiosis and complicated pneumoconiosis of which pulmonary massive fibrosis is one manifestation. Some investigators recognize a third form, pneumoconiosis associated with rheumatoid arthritis.

(2) Simple pneumoconiosis usually appears radiographically after 10 or more years' exposure to coal dust and is ordinarily associated with chronic bronchitis, as its only clinical manifestation. Pulmonary function studies at this stage are usually normal.

With continued exposure to coal dust, the radiographic picture is one of progression in size and density of nodules. At this point, emphysema begins to appear.

After a period of 20 to 25 years of exposure to dust, pulmonary massive fibrosis as well as extensive emphysema develop. Pulmonary function studies show alterations when the disease has progressed beyond the radiographic classification of simple pneumoconiosis, but do not always correlate with the X-ray findings.

Breathlessness in variable degree begins to occur once the process has extended beyond the simple stage, particularly in the presence of respiratory infection.

Pulmonary massive fibrosis is characterized by the progressive destruction of lung tissue centering around the coal nodules described by Gough. In the central and upper portions of the lungs this process is more rapid resulting in the coalescence of extensive areas of necrotic lung tissues containing coal dust to form tumor-like masses in one or both lungs. In approximately 50 percent of miners with pulmonary massive fibrosis, these masses may be several inches in diameter. Similar but smaller masses occur throughout the remainder of both lungs.

With the development of this situation, there is sufficient destruction of lung tissue, as well as of the blood vessels of the lungs, that death is the inevitable outcome; frequently resulting from heart failure. Tuberculosis has been shown to play no role in the development of this process.

(3) There is a time-dose relationship which seems to be related to the occurrence of coal pnuemoconiosis and pulmonary massive fibrosis. The amount of dust found in the lungs of most miners who died of pulmonary massive fibrosis was in the range of 20 to 25 grams.

A number of investigators think the development of pulmonary massive fibrosis may be related to a factor other than the time-dose relationship, since not all men with advanced coal pneumoconiosis develop pulmonary massive fibrosis. Four theories have been explored to some extent and are now less faborably regarded. It had been postulated that progressive massive fibrosis was the result of infection with tuberculosis. Other investigators held the view that it was the result of simple coalescence of fibrotic nodules. There has been considerable investigation of the role of the anonymous acid fast

bacteria. There was also the theory that infection with bacillary, other microbacterial or viral agents played a role in its pathogenesis. At the present time, the theory that immunologic factors are of major importance to the development of simple pneumoconiosis, as well as progressive massive fibrosis, is receiving major attention. The association of the rheumatoid factor with progressive massive fibrosis in Caplan's syndrome has been responsible for much of this interest. This concept is the subject of a joint study by Italian and British investigators. The total dust theory which is presently supported by most investigators roughly suggests that when a certain critical concentration of coal dust has been retained in the lung, the type of tissue response is altered and progressive massive fibrosis develops.

(4) There is no therapy for either simple pneumoconiosis or pulmonary massive fibrosis. Recent trials with antituberculosis drugs have not proved them to be effective. Attempts at prophylaxis against progressive massive fibrosis have centered around the use of high polymer materials. The trials of these materials have not been extensive, but there are few investigators who are optimistic about them. Adequate environmental dust controls or removal of minimally affected miners from dust inhalation seem to be the only successful procedures at this time.

(5) Evidence suggests that it is more important in environmental control and in epidemiologic studies to measure the total weight of respirable dust, rather than the total count. This concept is now supported in every European country and by practically all investigators. In the near future, the British plan to change their dust control standard from the present 850 particles per cubic centimeter as measured by the thermal precipitator to a respirable mass standard.

(6) Coal pneumoconiosis and pulmonary massive fibrosis are of great economic and public health significance. Throughout Europe the compensation costs for coal pneumoconiosis and pulmonary massive fibrosis are between three and four times as great as all other occupational diseases combined. In some countries costs approach one-half of the total cost of industrial accidents.

In the United States there is no body of information comparable to that existing in Europe. For this reason, American investigators have been largely dependent on the views and findings of European scientists. Prior to 1952, it was generally assumed by most American investigators that bituminous coal did not produce a disabling pneumoconiosis.

One of the eariliest significant clinical reports relating to the problem in the American mines was presented in a Symposium on Coal Miners' Pneumoconiosis at the Golden Clinic, Memorial General Hospital, Elkins, West Virginia, in 1952 [4] when Theodos presented the findings of an unselected group of some 1,000 hard coal miners and 185 soft coal miners with varying degrees of silicosis and disability. Theodos described coal miners' pneumoconiosis as a disease of the lungs resulting from the mining of coal and characterized by generalized fibrotic changes of various sizes ranging all the way from discreet nodules to conglomerate masses and manifested clinically by dyspnea and varying degrees of disability.

In 1952 the Division of Occupational Health discovered that a large part of the morbidity pattern of bituminous coal miners was due to diseases of the chest. As a result, the Division of Occupational Health reviewed the experience of a number of medical clinics located in the Appalachian bituminous mining area and other medical centers where coal miners were being sent for consultation. From this survey it was abundantly clear that there was a severe chest disease problem among bituminous coal miners. Although these clinics and medical centers reported a large number of cases, the data did not lend itself to an estimation of a prevalence rate. Of the cases observed in the clinics and medical centers many had evidence of emphysema frequently associated with chronic bronchitis, and poor pulmonary function with or without gross roentgenographic changes in the chest. The advanced stage of disease, to which no generic name had yet been given, was described as progressive, complicated by focal emphysema and irreversible. Disability, ranging from mild to severe, was usually associated with abnormal pulmonary function, particularly impaired ventilatory capacity. However, pulmonary function did not necessarily parallel roentgenologic changes. Limited autopsy data indicated a widespread symmetrical deposit of coal dust and discrete or conglomerate masses in the lungs with alteration of the normal pulmonary architecture and some associated fibrosis.

In 1957 Levine and Hunter [5] reported finding pneumoconiosis roentgenographically identical to that described by the British workers in a group of 153 miners from the Ohio River coal fields. Other investigators, including Martin of West Virginia, had reported similar findings from other coal mining areas. Subsequent studies by other investigators have developed more quantitative evidence that there is a severe chest disease problem among the miners in the American bituminous coal industry.

In November 1961, Lieben [6] reported on 5,072 coal workers in central Pennsylvania who were examined between April and November 1959. Although the study included a large proportion of underground and retired miners and did not permit a correlation between environmental conditions and medical findings, the author concluded that exposure to dust in the central Pennsylvania bituminous mining population resulted in significant pathologic changes; 28 percent of the population included in the study had roentgenographic evidence of pneumoconiosis.

Subsequent to the 1953 survey by the Division of Occupational Health, attempts were made to justify funds for an investigation of this problem in the American coal mines. It was not, however, until July 1962 that the Congress of the United States appropriated $100,000 for the fiscal year 1963 for a study of chest diseases in the bituminous coal workers These funds were subsequently increased to $512,000 for fiscal 1965.

Based on the interest of the Congress of the United States in the problem of chest diseases among bituminous coal miners, the Division of Occupational Health has designed a study whose objectives are (1) to determine the prevalence, pathology, etiology, and physiologic effects of chest disease in bituminous coal miners; (2) to determine the relationship between chest diseases in bituminous coal miners and the working and living environment of the miner; and (3) to determine the preventive medical and engineering measures.

In view of the dearth of definitive morbidity data on bituminous coal miners in the American mines, our first task was to determine the prevalence of the chest disease in this group. To accomplish this, a sample of 2000 active miners and 1000 inactive miners was selected from Title 2 mines in the Appalachian area in such a manner that an accurate estimate of the overall prevalence rate could be established.

The medical study included a 14 x 17 inch chest X-ray, a thorough clinical and occupational history, and standardized pulmonary function tests. The details of the study including the method used for selecting the mines may be found in two publications of the Division of Occupational Health, one entitled "Proposal for the Study of Chronic Chest Diseases in Bituminous Coal Miners," [7] and the other, "Summary Report. Chest Diseases in Bituminous Coal Miners" [8] which contains the minutes of a meeting with the coal industry and labor unions at Charleston, West Virginia, December 1962.

To differentiate between occupational and nonoccupational exposures, and to determine what effect the living environment may have on the development of chronic chest diseases, the adult population of two communities, Mullens and Richwood, West Virginia, whose population consists of coal miners and persons working in noncoal industries, will be studied. As a control, the workers of a paper and pulp plant exposed to carbon dust have also been examined.

The films are being read by a panel of outstanding radiologists consisting of Dr. Eugene Pendergrass from the University of Pennsylvania, Dr. Benjamin Felson of the University of Cincinnati, and Dr. George Jacobson of the University of Southern California. To prevent biased readings the films of the community population of Mullens and the paper plant were interspersed with the coal miners' films. Concurrently, the panel has also read films from the silicosis study in the metal mining industry and a selected group of films from asbestos workers.

The preliminary field study was to have been completed by October 1964, but due to inclement weather conditions during the winter of 1962-63 and as a result of a higher than anticipated response rate, the study will not be completed until December, 1964, about two months later than the projected completion date. By then, 2,700 active and 1,300 inactive miners will have been examined.

The response rate of 92 percent, rather than the anticipated 75 percent, accounts for the larger number of workers examined than was originally proposed. Because of the presumed high rate of disability that has been reported from Cambria County, Pennsylvania, this County was also studied during the course of the preliminary investigation. The results from this County will not be included in the results of the prevalence study, but will be reported on separately.

Due to the availability of greater funds in fiscal year 1964-65, the Division of Occupational Health was able to begin basic studies of the pathology and etiology of the diseases and to tool up for the necessary environmental studies. The analysis of the medical data is reasonably current and lags only slightly behind the field teams. It is our desire to have completed the analysis of the data by mid 1965, after which a full report of the preliminary investigation will be made. At the risk of reporting prematurely on the findings, it may be said with some degree of confidence that the problem in the American mines appears to be similar to that which has been reported by British and European investigators. Thus, it is evident that a national research effort is necessary if this costly disease is to be prevented.

The dimensions and direction of such an effort are under study by the Division of Occupational Health. It is immediately evident, however, that long range prospective studies will be required in several different fields.

First, environmental studies in the coal mines are essential. Such studies will be necessary to determine the relationship of the work environment to pulmonary diseases and disability. Pilot environmental studies are being planned in cooperation with the U. S. Bureau of Mines. Various sampling procedures, techniques and instruments are currently being investigated by the two agencies. Methods of study are under review and it is hoped that these can be field tested in the next few months.

As a corollary to these environmental studies, it will be essential to collect medical data bearing on the health status of the worker in these mines. First, as a means of determining the dose-response curve for respiratory diseases, and later as a means of monitoring the effectiveness of the controls.

The Division of Occupational Health of the Public Health Service has a 50-year history of research in the occupational diseases and through its efforts, the incidence of occupational diseases has been greatly reduced in the American industry. During this period, this Division has established a worldwide reputation for its classic epidemiologic studies of the pneumoconioses, especially silicosis, which have been the basis for establishing standards for the diagnosis and prevention. The European countries have far surpassed our efforts in the study of coal pneumoconiosis. While there may be some disagreement with the European authorities on certain principles regarding control, prevention, and compensation, the European evidence is overwhelming in its proof of Agricola's thesis that "the lungs of miners sometimes rot away." Evidence is available to indicate that there is little difference in the biologic effect of European and American coal. Such proof should be forthcoming shortly.

In addition to providing a service to the coal miner and to the coal mining industry, the Division of Occupational Health views this opportunity of studying coal pneumoconiosis as a bridge to research into the entire field of respiratory diseases among workers. The evidence is abundantly clear that bronchitis and emphysema are becoming of greater significance in the morbidity and mortality pattern of the entire population. Except for workers exposed to dusts and fumes, there is little evidence to implicate the working environment as a contributor to the increasing prevalence of respiratory diseases. There is evidence, however, that properly designed and conducted studies of the working population and the work environment may be the key to its etiology, and may lead ultimately to the means for preventing one of our major health problems.

In closing, the Division of Occupational Health should like to take this opportunity to express its great appreciation to the mining industry, the national and sectional coal associations, the United Mine Workers, the U. S. Bureau of Mines, and to the individual coal workers, both active and retired, for their splendid cooperation. A response rate among the miners of over 90 percent is dramatic proof of interest in their own health problems. We are also grateful to the various State agencies, the universities, the municipal authorities in Mullens and Richwood, the presidents of local United Mine Workers unions, and others whose cooperation has made this kind of investigation possible.

REFERENCES

1. Georgius Agricola. De Re Metallica. Translated from the First Latin Edition of 1556 by Herbert Clark Hoover and Lou Henry Hoover. Dover Publications, Inc. New York 1950.

2. A Medical Survey of the Bituminous Coal Industry. Report of the Coal Mines Administration, U. S. Department of the Interior, U. S. Government Printing Office, Washington. D. C., 1947.

3. Collins, E. L. and Gilchrist, J. C. Effects of Dust on Coal Trimmers. J. Ind. Hyg. 10: 101-110, 1928.

4. Theodos, P. A. Clincial Aspects of Coal Miners' Pneumoconiosis. In Symposium on Coal Miners' Pneumoconiosis, The Golden Clinic, Memorial General Hospital, Elkins, West Virginia, 1952.

5. Levine, Milton D. and Murray B. Hunter. Clinical Study of Pneumoconiosis of Coal Workers in Ohio River Valley. J.A.M.A. 163:1, January 5, 1957.

6. Lieben, J., Pendergrass, E. and McBride, W. W. Pneumoconiosis Study in Central Pennsylvania Coal Mines. I. Medical Phase. Journal Occ. Med. 3, 1961.

7. Proposal for the Study of Chronic Chest Disease in Bituminous Coal Miners. Division of Occupational Health, Public Health Service, U. S. Department of Health, Education, and Welfare, Washington, D. C. 1962. Processed.

8. Summary Report. Chest Diseases in Bituminous Coal Mines. Minutes of meeting held at Charleston, West Virginia, November 19-20, 1962. Division of Occupational Health, Public Health Service, U. S. Department of Health, Education, and Welfare, Washington, D. C. Processed.

BANQUET ADDRESS

John K. Tabor, Secretary
Department of Commerce
Commonwealth of Pennsylvania

Your deliberations here at this conference are concerned with one of the many urgent problems which confront Pennsylvania and Pennsylvanians daily.

This pinpointed effort, combining the best talents of private citizens and government, to provide a workable solution to a problem is an excellent example of what must be done and, in fact, is being done on a broad front to improve the economic health and general well-being of all Pennsylvanians, including those in the mining regions.

The Scranton Administration has committed itself to an all-out attack on the sources of disease, deprivation, and despair wherever they exist in our Commonwealth. It has committed itself to use to the fullest appropriate extent every tool available and to develop new tools as they are needed.

It is our unwaivering goal to put Pennsylvania back on top in every field of human endeavor--in jobs, in education, in health, in highways, in compassion and aid for the needy.

This commitment, for example, has been producing remarkable results in the creation of fruitful and enduring job opportunities for our citizens. In October, the unemployment rate in Pennsylvania dropped to an eleven-year low of 4.3 per cent for the month. It was less than the national rate for the second time during the Scranton Administration, since modern record keeping began. The number of announcements of new plants or expansions of existing ones established a modern record last year; this year looks even better. The income generated by tourism in Pennsylvania this year is expected to exceed last year's by 20 per cent.

The news has been equally good in our mining areas. In September, the unemployment rate in the Scranton labor market area was 7.3 per cent as compared to 9.2 per cent in 1963. In Wilkes-Barre-Hazleton it was 6 per cent as compared to 8 per cent in 1963.

By a successful and unique combination of effort, ingenuity and imagination of the private sector, local communities, charitable groups and public officials, Pennsylvania has made great progress on many fronts.

Two new programs devised by the federal government hold some promise of providing additional tools which, with the many other public and private tools now in existence, can help to create opportunity for more people in Pennsylvania. They are the so-called "Appalachia Program" which is expected to be passed by the Congress in this next session, and the "Anti-Poverty Program," or the Economic Opportunity Act of 1964 which was passed by the last Congress.

There is a very definite distinction between the two. The Anti-Poverty Program may be thought of as dealing with human resources, while the Appalachia Program deals with physical resources in the geographical region covered by the Appalachian range.

The Economic Opportunity Act is a massive federal program for which almost $1 billion has been appropriated to be spent in several areas of activity. These are described as: Youth Programs, such as the Job Corps; urban and rural community action programs; special programs to combat poverty in rural areas; employment and investment incentives; and work experience programs. The role of the states in the program as far as the act itself is concerned has been relegated to that of a veto power. However, it would be tragic to waste or dissipate in short-range or ill-conceived schemes, the funds to be made available to Pennsylvania communities under this act. Therefore, Governor Scranton has determined that it is this Administration's obligation to see to it that Pennsylvania communities obtain an equitable share of the available money and use it for effective work at the local level.

The state will concentrate on the community action program portion of the act. We have established a division of Economic Development within the Department of Commerce to co-ordinate the interests of the various state departments in the program. These Departments include: Labor and Industry, Public Welfare, Public Instruction, and Health. And each Department has assinged a well-qualified representative to work with the Department of Commerce.

The Governor has instructed all hands to go all out in—

1. Stimulating the development of effective and useful community action programs that would be particularly helpful in our smaller communities, such as are found in the coal regions. The larger cities that have available technical personnel will probably work directly with the federal government.

2. Assisting these communities in designing specific community action programs to meet their existing needs. These programs can be in the fields of housing, education, medicine—anything the imagination can create to cure the root causes of poverty.

3. Reviewing programs to be sure that they meet four basic criteria established by the Governor. These criteria are:

A. To attack not merely the symptoms, but the root causes of poverty.

B. To offer not merely short-range and temporary palliatives, but enduring long-range solutions to poverty.

C. To foreseeably produce improvement of many persons and not merely benefit narrow or special interest groups.

D. To make clear the willingness and ability of the communities to support the proposal financially both at present and throughout the life of the proposal.

The Appalachia Program, as it was originally conceived was almost entirely federally oriented. Through the efforts of Pennsylvania, primarily, greater recognition of the vital role of the individual states was given in the bill actually presented to the Congress last year. It is expected that the bill to be presented this year will be basically the same.

The program covers four areas which are of particular interest to Pennsylvania. These are: mine area restoration; demonstration health facilities; highways; and technical education.

$13 million would be made available for repairing mine caving and subsidence damages, putting out underground mine fires, restoring strip mine areas, eliminating burning and non-burning culm piles, eliminating mine drainage water pollution. Only $3 million had originally been provided for these purposes. Governor Scranton was instrumental in convincing the President to increase this to $13 million. It is expected that Pennsylvania will get a substantial portion of this money.

Money would be provided on a grant basis for the construction, equipping, and operation of multi-county demonstration health facilities. This includes hospitals, regional health diagnostic and treatment centers and other similar facilities.

In highways, the federal government would supply matching funds for a major highway that would traverse the Appalachian region. Funds may also be available for feeder roads.

In education, funds would be made available for the construction of vocational-technical school buildings. This would supplement and expand the vocational education program passed by Congress in 1963.

In anticipation of the passage of this program, the Governor has mobilized the appropriate agencies of government to take full advantage of the opportunities presented. A coal task force has been set up within the government to co-ordinate mine area restoration programs and Secretary Charmbury has a number of projects already lined up and ready to go. Also, the Health Department, the Highways Department, and the Department of Public Instruction are now developing projects to tie in with the Appalachia Program.

Of course, we have no assurances that any of these programs will provide all of the answers to Pennsylvania's problems but we are determined to utilize every opportunity, every tool, every individual that can contribute to the building of a better Pennsylvania for all of us.

THE SPECTRUM OF PNEUMOCONIOTIC DISEASE IN PENNSYLVANIA

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The purpose of this discussion is to consider some of the fundamental problems of Pneumoconiosis in Pennsylvania.

One important problem concerns the general nature of the lung disease produced by industrial dust inhalation in this state. Historically, there have been two viewpoints. One viewpoint holds that the inhalation of coal dust, per se, is incapable of producing disease. Exposed individuals developing lung disease do so because of the presence of quartz (containing silica) and if the quartz were not present there would be no disease. This view has been most widely accepted in Pennsylvania. As a matter of fact, Dr. Sayers at the International Conference on Silicosis in Geneva in 1938 summarized the results of the Pennsylvania Enquiry as follows: quote, "The enquiry had led to the conclusion that the disease and resulting disability found in the anthracite miners were due to inhalation of a mixed dust composed of silica and coal; that the pathological changes were due primarily to silica being subsequently modified by the presence of coal dust; and that the condition was one which could be controlled by methods now available in the mining industry," unquote. This view has given rise to the term Anthracosilicosis which is codified in the law of this state and continues to be used as witness the very title of our present deliberations.

The opposite view is that lung disease may be produced by the inhalation of large quantities of coal dust, per se, independent of quartz. Quartz may be present in small amounts but this is accidental and the disease would be essentially the same if quartz were completely absent.

This view has been chiefly supported by the British and Russian workers and has received increasing recognition in this country. This view has given rise to the term coal workers' pneumoconiosis to designate the lung disease produced by excessive inhalation of coal dust.

It should be pointed out that this controversy is more than a semantic problem. One cannot imitate Humpty Dumpty in "Alice in Wonderland." You may recall the conversation between Humpty Dumpty and Alice --

"When I use a word," Humpty Dumpty said in rather a scornful tone, "it means just what I choose it to mean - neither more or less."

"The question is," said Alice, "whether you can make words mean so many different things."

"The question is," said Humpty Dumpty, "which is to be master - that's all."

There are a number of important practical consequences which flow from adopting the view that coal workers' pneumoconiosis exists as an entity distinct from silicosis. These include the following:

1. The population at risk is obviously much greater since quartz contamination may be minimal in a number of industrial operations involving coal.

2. The natural life history of coal workers' pneumoconiosis may be quite different from silicosis and thus diagnostic measures, therapeutic measures, and preventive measures might be quite different in the two diseases.

3. The social and legal superstructure required for handling the two diseases might require different approaches.

The evidence that coal workers' pneumoconiosis is a distinct disease includes the following:

1. The early lesion in coal exposure is relatively distinct from that in silicosis. This lesion shows coal dust collections and results in isolated areas of so-called focal emphysema. In classical silicosis, the nodules frequently come closer together as a result of fibrosis contraction; but coal nodules, on the other hand, tend if anything to go further apart as the disease develops due to the occurrence of emphysema.

2. The advanced symptomatic lesion is called progressive massive fibrosis. It cannot be differentiated clinically from late lesions occurring in silicosis. However, it occurs in a number of situations where there is no real possibility of silica exposure. Progressive massive fibrosis, identical with that of coal workers, is seen in carbon electrode makers. Analyses of these cases have shown that the dust in the lung contains minimal amounts or no free silica.

Coal loaders at the dock may develop progressive massive fibrosis although exposure to silica is minimal or absent. Chemical analysis of lungs from such patients show large amounts of coal and insignificant to zero amounts of silica. In silicosis, on the other hand, large quantities of silica generally are found.

Thus, it seems clear that severe lung damage can occur in individuals exposed to coal dust for suitable periods of time in the absence of silicosis.

Assuming for the moment that coal workers' pneumoconiosis is a distinct entity, there are several clinical variations which occur in coal workers which illustrate the medical and social problems involved. These include simple pneumoconiosis, progressive massive fibrosis, tuberculosis, chronic bronchitis and obstructive emphysema, obliterative cor pulmonale, and Caplan's and Caplan-like Syndrome. Simple pneumoconiosis represents the most common variety of coal workers' pneumoconiosis. It is frequently a diagnosis which is made on the basis of chest x-ray findings which may show, in a suitably exposed individual, discrete small nodules, increased lung markings, or a reticular pattern. Pulmonary function studies suggest that, in general, function is not significantly abnormal and that this variety of pneumoconiosis is not disabling. However, there are several lines of evidence which suggest that this entity is a disease and not an incidental finding.

1. There are definite abnormalities found on histologic examination of the lung. These changes have been given the generic title of focal dust emphysema.

2. There is evidence that focal dust emphysema may predispose the lung to more serious damage by other pathological agents.

3. With advancing age these individuals may develop breathlessness. This breathlessness is too severe to be accounted for merely on the basis of aging alone. This fact illustrates an important concept that will be stressed below, namely that many years may elapse between the injury produced by dust and the time that frank manifestations of clinical disease become apparent. This lag period varies from disease to disease as well as from patient to patient.

Another variety of coal workers' pneumoconiosis has been called progressive massive fibrosis. In this variety, there is the development of severe pulmonary scarring involving small to large segments of the lung. In this variety, x-ray changes are extensive although the x-ray picture is by no means specific. The patient with progressive massive fibrosis suffers from progressive shortness of breath. Pulmonary function studies frequently show clearcut and extensive abnormalities. Patients frequently die of either pulmonary insufficiency or of heart disease caused by their pulmonary abnormality.

Pulmonary Tuberculosis: There appears to be a more or less clearcut relationship between pulmonary tuberculosis and coal workers' pneumoconiosis. This relationship expresses itself as an increased susceptibility to pulmonary tuberculosis in these patients; the development of frank pulmonary fibrosis as the sequel to the presence of both diseases (indeed, it is held by some that progressive massive fibrosis represents the combined result of coal dust and tuberculosis on the lung) and in a greater than average death rate from pulmonary tuberculosis in coal miners.

Chronic Bronchitis and Obstructive Emphysema: Chronic bronchitis is a disorder which is characterized by cough, sputum, and in advanced stages by shortness of breath. Obstructive emphysema is characterized by progressive shortness of breath and pulmonary insufficiency and secondary heart failure in extreme cases. Both these disorders are not uncommon in the general population. Factors such as smoking and air pollution appear to be of great importance in the pathogenesis of these diseases. However, it appears that they are significantly more common in coal workers than in the general population. It seems that this increased incidence is a direct result of increased dust exposure in coal workers. There are several points of interest in this respect.

One point is that radiologically, coal miners with chronic bronchitis may actually show fewer x-ray abnormalities than coal miners without bronchitis. X-ray studies are thus not necessarily an accurate diagnostic guide in such patients. This illustrates the point that, in many varieties of pneumoconiosis there is poor correlation between x-ray abnormalities and functional abnormality. Patients with extensive x-ray findings may show good lung function, and conversely, patients with minimal findings may have extensive involvement.

Another problem is that chronic bronchitis and obstructive emphysema may develop an indefinite number of years following exposure to coal dust. Thus, the problem of variations in time between exposure and the development of obvious disability is important in these patients.

Thirdly, chronic bronchitis and obstructive emphysema are common in the general population. Thus, in a given coal miner who develops these disorders the problem arises as to whether the disease was acquired as a result of exposure to coal dust or whether the individual would have acquired these diseases independent of dust exposure. In an individual patient this question may be difficult or impossible to answer. And, what may be required is a general policy to decide whether chronic bronchitis in a coal miner with adequate history of exposure, a priori, should be regarded as having developed this disease as a result of exposure. It does seem clear, from the medical standpoint, that individuals with chronic bronchitis/emphysema should be removed from further exposure to dust inhalation.

The next variant to be considered is cor pulmonale. Cor pulmonale refers to the type of heart disease that occurs as a result of lung disease. This form of heart disease is associated with a large heart - this enlargement specifically involving that chamber responsible for pumping blood through the lung - the right ventricle. As the disease advances there may be fluid retention or edema; the liver becomes large; and ultimately the output of blood by the heart becomes too small to support normal activities. Ordinarily this variety of heart disease does not become apparent until lung disease is quite far advanced and obvious. This may not be the case in coal workers' pneumoconiosis. The fibrotic process in this disease may specifically involvethe medium sized blood vessels in the lung. As a result the right ventricle may have to work excessively hard to force blood through the narrowed blood vessels. As a result, cor pulmonale may occur in such patients even in the absence of severe lung disease.

The final form of coal workers' pneumoconiosis is Caplan's Syndrome or Caplan-like disease. Caplan is a British radiologist who described the development of large discrete nodules of fibrosis in the lung of coal workers who had another disease - rheumatoid arthritis. Since the original description, it has become apparent that there is an accelerated tendency for the development of fibrosis in the lung of coal miners who may not have overt rheumatoid arthritis, but whose blood contains certain chemical substances known as antibodies, similar to those found in patients with rheumatoid arthritis - this variant might be called Caplan-like syndrome. The importance of these findings is that the antibodies which seem to be important in the development of fibrosis in some coal workers may also be found in the blood of close relatives of patients with rheumatoid arthritis. In other words, the tendency for the development of abnormalities in the lung may be related to inherited or genetic factors. Thus, the great variation seen in the development of lung disease in a population of patients who have essentially the same degree of exposure may be related to inborn and potentially identifiable factors which increase susceptibility in those who develop frank disease.

This discussion has been presented in a rather cut and dried fashion. In life, the operation of the factors discussed is much more complicated and less clear. However, it represents a reasonable summary of present data.

Having outlined briefly some of the clinical features of coal workers' pneumoconiosis, and some of the medical problems involved in the area, I would now like to devote some time to possible operational approaches to these problems. To do so, would like to present five general proposals which might be valuable in solving some of the problems posed by pneumoconiosis.

The first proposal would be to establish a State Board on Pneumoconiosis. This Board would be composed of a number of experts in the fields of Medicine, Biology, and Engineering. Its function would be to survey the field, highlight problems, define areas of work and integrate scientific activities. Although not directly involved in the legal problems of compensation or social problems, the work of this committee would provide information of great value in those areas. Of great importance is the fact that this state is particularly rich in scientific facilities, Medical Schools, Universities, and organizations such as Mellon Institute capable of making important contributions in the field of pneumoconiosis. The organization of such a Board could serve to mobilize these facilities.

A second proposal would be the organization of pulmonary screening centers for coal workers. These centers would be equipped to carefully evaluate the clinical status of large numbers of miners by means of history, physical examination, x-ray, and functional evaluation of the lungs. It could serve a number of important functions:

1. Pick up of early disease in a hopefully reversible stage.

2. Provide invaluable information concerning the prevalence and natural life history of pneumoconiosis.

3. Provide data of great value in assessing disability for legal and social reasons.

A third approach concerns the modification of the tuberculosis sanitoriums. It is well known that profound changes are taking place in the field of tuberculosis. The number of affected patients with the disease is declining. In addition, the therapy of tuberculosis is becoming increasingly feasible on an ambulatory basis. More general hospitals are being involved in the treatment of patients with active disease. As a result, the in-patient population of the state hospitals is declining.

As indicated above, the problem of pneumoconiosis is a part of a more general and important problem, the problem of chronic respiratory disease. Chronic respiratory disease is an increasing cause of morbidity and mortality in the state. It would seem reasonable to consider converting the present facilities from centers for the treatment of tuberculosis to centers for the treatment of chronic pulmonary disease, including pneumoconiosis. Such a program would have a number of advantages:

1. There is no doubt that in-hospital care of such patients on a long-term basis can be life saving and thus, would fulfill an important need.

2. Re-organization of these facilities would permit a fresh approach to the organization of such facilities. The classical tuberculosis sanitorium has suffered from 2 major defects.

   a. The isolation of the patient from the outside world. The frustrations of life in a sanitorium can be extreme. One only has to recall the eloquent description of life under these circumstances by Thomas Mann in, "The Magic Mountain," to know the despair that may exist.

   b. Medical staffs of tuberculosis sanitoriums have been largely isolated from the main stream of medicine. As a result there has been low morale and difficulties in recruitment of physicians, nurses, and auxiliary personnel. Rather than being centers of medical science and superb patient care, they are less than top flight.

Conversion of these hospitals to centers for the care of respiratory disease could be accomplished in such a manner that both defects were eliminated.

An extensive program of in-hospital rehabilitation could be inaugurated. Programs of gainful occupation on an in-hospital basis, designed to operate within the physical limitations of the individual patient would be feasible. Thus, the quality of life for these patients, as well as the quantity of life, could be improved.

For up-grading medical life, it might be suggested that the medical schools in the state be directly involved in the development of medical standards.

A dean committee type of arrangement which has worked well in the Veterans Administration could be set up for the individual units. The hospitals could serve as training centers for both undergraduate medical students and post graduate physicians. With the breath of fresh life furnished by medical schools, the hospitals could serve as centers for clinical research, for screening respiratory disease in substantial segments of the population including coal workers; and for evaluation of the efficacy of various therapeutic regiments.

In other words, a bold and imaginative approach to the use of in-hospital facilities for the long-term treatment of respiratory disease would permit this state to play an exciting and pioneering role in a vitally important area.

A fourth proposal concerns the development of firm support for basic research in the area of pneumoconiosis. Major emphasis in the past has been given to descriptive studies using such techniques as x-ray surveys; statistical evaluation of incidence; epidemiologic surveys; and pulmonary function screening. Although studies of this type are important, by themselves, they cannot define the mechanisms and etiological basis of pneumoconiostic disease. And without knowledge of mechanism, the problems of prevention, treatment, and cure must be handled empirically and generally unsuccessfully.

It would seem reasonable that any program designed to meet this problem should include a substantial emphasis on such problems as the biochemistry of the lung, the immunochemistry of the lung, metabolism of lung tissue, andbiophysics of the lung as a function of dust exposure. Basic research offers the further dividend that such studies would result in information of great value in other diseases in addition to pneumoconiosis. It would also serve to recruit well-trained, critical-thinking scientists to an area of study which badly needs such people.

The fifth proposal would be to consider modification of the existing state law concerning occupational diseases. I, personally, feel particularly unqualified to discuss this proposal, at length, but it seems to me the present law has at least 4 unrealistic and thus presumably unjust features:

a. The insistence on silica as a sine qua non of the respiratory disease found in miners.

b. The establishment of an arbitrary period of time as a limiting factor in compensation - since it is clear that there is great individual variation in the development of structural and functional abnormalities following exposure.

c. The insistence that the disease to be compensable must be uncommon in the general population - after all, the lung can only react in a rather limited number of ways and as indicated the problem of deciding whether a given miner developed chronic bronchitis as a result of coal dust or would have developed it anyway had he not been exposed, is impossible to answer specifically. What, therefore, is required is a general policy that best serves the basic needs of this state.

d. The present systems of determining compensability are inadequate. Scientific and medical criteria developed by scientific personnel, is the only acceptable method for insuring a just and effective compensation system.

These questions will undoubtedly be considered at greater length in the special sessions.

The final point concerns the scope of the problem of pneumoconiosis in the years to come. Coal mining is in a transitional phase from a high risk, high employment industry to a low risk, low employment industry. This results from 2 factors which will limit the future importance of this problem in Pennsylvania.

1. Increased efficacy of dust disposal in mines so that the degree of exposure is less.

2. Growing automation in mining operations so that the population at risk will be smaller in years to come.

Thus, essentially, one is dealing with a reservoir of patients in their 40's, 50's, and 60's, and this reservoir will become progressively smaller with the passage of time.

However, this is no reason for inaction. An acceptable program is required for those previously exposed and now being exposed. In addition, chronic respiratory disease will continue to be a problem for many years. What is done in the field of pneumoconiosis will have important relevance for the area of chronic respiratory disease, and thus aggressive action is certainly justified and required.

CLINICAL ASPECTS OF ANTHRACO-SILICOSIS

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The research program for the study and treatment of anthraco-silicosis at the Jefferson Medical College Hospital under auspices of the Anthracite Health and Welfare Fund was initiated in 1948 and is now in its 16th year.

To date 2176 hard coal miners and 202 soft coal miners have been studied. About 40 percent of the hard coal miners have been restudied for a total of 1392 re-visits. 1065 or 49 percent have died. Experience has been with about 1.0 percent of the total number of miners known to have worked in the hard coal industry.

An x-ray classification has been used based on the size of the nodule. Stage ONE consists of diffuse or widely scattered nodules up to 2 mm in diameter. Stage TWO of nodules from 2 to 5 mm in diameter, and Stage THREE of nodules over 5 mm in diameter, discrete or joined together in coalescent or conglomerate masses.

Many miners with adequate exposure have essentially negative x-rays or changes not typically nodular. These have been classed as negative, where nothing abnormal is seen, borderline, where only accentuation of the lung markings is present and atypical or linear where fibrosis without nodulation is present.

Of the first 2152 hard coal miners so far studied, classification is as follows:

STAGE	NO.	PERCENT
Normal	78	3.6
Borderline	59	2.7
First Stage		
Nodular	86	4.0
Atypical (linear)	79	3.7
Second Stage		
Nodular	244	11.3
Atypical (linear)	115	5.3
Third Stage		
Nodular	130	6.0
Coalescent nodular	608	28.3
Conglomerate	753	35.1

Only 6.3 percent are classed as normal or borderline and 9.0 percent as atypical or linear. 21.1 percent are nodular and 69.8 percent are classed as 3rd stage. Roughly one out of three cases is conglomerate.

The diagnosis of anthraco-silicosis offers no problems in the typical case. However, the relationship of the borderline and atypical case to the diagnosis of anthraco-silicosis has been studied by means of a limited intercostal biopsy under local anesthesia. The usual site of biopsy is in the anterior part of the chest where the rib spaces are wider. As the pleura is opened, the lung is kept expanded by oxygen given under pressure through a snugly fitting mask, and as the lung protrudes through the incision a piece is removed.

To date 39 miners have been studied by this means. The diagnosis of anthraco-silicosis was established in one of six cases classed as normal by x-ray, three of sixteen with borderline changes, 6 of 11 with atypical or linear x-rays and 3 of 6 with nodular changes, by this technique for a total of 34 percent of the biopsies. In two of these cases the diagnosis of anthraco-silicosis was established only after a second biopsy in each case. It is evident that a classical x-ray appearance is not always necessary to establish the diagnosis of silicosis. Through use of the biopsy technique a precedent has been established in the courts of Pennsylvania whereby a lung biopsy done during life of a miner can be entered in evidence in support of a claim for compensation.

The stage of anthraco-silicosis is not necessarily static. Two questions need to be answered. The first has to do with whether when once exposed does progression of silicosis occur anyway regardless of whether further exposure takes place. The other relates to the influence of continued exposure on the rate and degree of progression. Neither of these questions can be answered from the experience at Jefferson but it is evident that from 10 to 15 percent of the cases studied have shown progression by x-ray when subsequently readmitted.

It appears that the borderline or simple nodular case seldom goes on to the conglomerate form whereas the coalescent nodular does progress frequently into the conglomerate form. In those cases that have shown progression, a precipitating cause has not been evident and further work exposure had not taken place.

As a rule the diagnosis of anthraco-silicosis is based on a history of adequatc exposure and x-ray evidence of disease. It is common practice to grade the severity of the disease according to the extent of x-ray changes. The natural implication of this is that the degree of clinical disability parallels the degree of silicosis by x-ray. It is often true that the greater the degree of silicosis, the greater the amount of pulmonary disability present, especially when conglomerate lesions are present. However, frequent exceptions are noted. It is not uncommon to find two miners of comparable age and exposure with similar x-ray evidence of disease but who differ in degree of impairment. It is also not uncommon to see an advanced degree of disease by x-ray with little disability or little disease by x-ray and more impairment. This can be explained by the fact that the x-ray picture correlates well with the anatomical degree of silicosis, but the patient's symptoms depend on the degree of function impairment, and these two factors are not always equivalent. As a rule the impairment in anthraco-silicosis is ventilatory in nature of the obstructive type. The degree of ventilatory insufficiency is more closely related to the distribution of the lesion than to the absolute amount of fibrosis present.

Emphysema is a complication and sequel to anthraco-silicosis. The degree of disability is more related to the degree of emphysema than to the stage of silicosis. There is therefore, a discrepancy between the x-ray stage of silicosis and the disability depending on the amount of emphysema present. Because the symptoms are usually caused by a ventilatory dysfunction and are closely related to the emphysema, physiological measurements of function will give a more accurate picture of the disability present than will the chest x-ray.

Anthracite miners are subject to the same infectious, metabolic and degenerative disease as non-miners and an appreciable amount of heart disease, hypertension, gastrointestinal disturbances, urinary problems, and non-specific infections have been detected. These conditions and many others, either individually or in combination have been significant considerations in about 50 percent of the cases regardless of the degree of pulmonary function impairment due to anthraco-silicosis per se. Time will permit discussion of only three conditions – tuberculosis, carcinoma of the lung and ischemic necrosis.

It is known that tuberculosis is not an infrequent complication of anthraco-silicosis, and the most common cause of cavitation. On the basis of recovery of acid-fast bacilli in the sputum by smear or culture, 15 percent of the miners have been found to have tuberculosis at time of the original admission or on subsequent observation.

A definite correlation exists with the age of the miner, the length of industrial exposure and the degree of silicosis. It occurs more frequently in the 4th and 5th decades of life and is more commonly associated with third stage silicosis. The complication should be suspected when a sudden deterioration in the health of the miner takes place, when localized moist rales are present in one part of the lung or where the x-ray shows asymmetry, coalescence or cavitation.

Cavitation in anthraco-silicosis is quite common, occurring at some time or other in 10.3% of the cases studied. A positive sputum has been recovered in 139 of the 191 cases (73%) and the cavitation can be presumed to be due to tuberculosis. In 23% of cases cavitation cannot be accounted for on any other basis and it would appear likely that cavitation has resulted from ischemic or aseptic necrosis. This entity has been observed in 74 cases, or 3.4% of the 2176 miners studied. It occurs when breakdown of lung tissue takes place in an area deprived of its nutrient blood supply by massive fibrosis. It is most frequently seen in the center of large conglomerate masses. Microscopically the blood vessels within these masses show arteritis and phlebitis of high grade. A marked obliterative enarteritis and thickening of the intima with reduction in size of the lumen is present. Necrosis with liquifaction occurs in the area deprived of its blood supply. The patient may suddenly cough up a large quantity of black material which contains no organisms. The cavities may repeatedly fill and empty over a long period of time. The clinical course is generally benign and no isolation or special treatment is required. The presence of such non-tuberculous cavitation is more common than clinically appreciated. Some of the large conglomerate masses seen on x-ray may contain filled-in cavities and appear solid as they are not in communication with the bronchi. This can be demonstrated by transthoracic puncture as done in two cases in this series where black material was obtained after introduction of a needle into conglomerate areas.

Carcinoma of the lung has been found to be present in 39 cases or 1.8% of the 2176 miners studied by analysis of tissue obtained by bronchoscopic biopsy, peripheral lymph node biopsy, needle biopsy of the pleura or exploratory thoracotomy. The relationship between silicosis and carcinoma of the lung is uncertain and the current concepts suggesting no causal effect may be in error.

Recommendations

Clinical experience with miners afflicted with anthraco-silicosis indicates the need for alteration of the present practices as follows:

1. There is need for pre-employment x-rays to prevent hiring of workers with tuberculosis and other conditions and to provide a base line film for comparison with other films later.

2. Periodic x-rays should be taken during the employment period to permit detection of early silicosis, progression, and the presence of complications such as tuberculosis or carcinoma.

3. Revision of the existing compensation laws should be effected to provide for partial disability and extension of the present statute of limitations to beyond 4 years since silicosis may become manifest much later.

EXPERIENCE WITH A PERIODIC X-RAY PROGRAM FROM AN INDUSTRY MANAGEMENT'S POINT OF VIEW

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As you know, prior to the passage of Workmen's Compensation Occupational Disease Laws, very few companies included chest x-rays as a part of their pre-employment physical examinations. When the law was passed in our state, management decided that something would have to be done about pre-employment chest x-rays and also the x-raying of employees who were then on the payroll.

The first consideration was a study as to the cost of having the x-rays taken by an outside source versus buying an x-ray machine and doing our own. Since the closest unit was approximately five miles away and this would involve men being away from their work for one to one and one-half hours, a decision was made to purchase our own machine. Another reason for this decision was that we would be able to x-ray injuries that occured in the plant.

And so the machine was purchased, a room with adequate protection was built, the nurses trained to take chest and simple x-rays and we were ready to do business. A Roentgenologist agreed to read the x-ray on a per case basis.

A program was started to x-ray every employee working in a silica hazard. We felt that after this had been done we would x-ray the rest of the employees who worked in the non-silica areas such as the Machine Shop.

After we had taken a number of x-rays we realized that we had a problem. We found a number of employees with different degrees of silicosis. We could not determine if they had contracted the disease in our plant because prior to this time molders for example, had a habit of shall I say "job jumping". You must remember there were no pension plans and other fringe benefits which provided an incentive for the men to stay with one employer.

From these first x-rays we could not establish a pattern. For example some men who had worked in our plant in a silica hazard for 15 to 20 years showned no more than normal lung changes. Other employees who had been with us for only five years had silicosis. In every case they had a prior exposure - many had worked in coal mines.

I can remember six molders with whom I had worked and with whom I had become well acquainted. I watched for their yearly x-ray readings to see if anything was happening to my former co-workers. The whole group went for a number of years before two of them showed lung changes and eventually developed silicosis. The other four retired when they reached retirement age with apparently no silicosis. I have often wondered why the two and not all six contracted silicosis doing the same work and working in the same area. As I mentioned earlier, I am not an expert in this field and have no possible answer to this question. However, I think that it is an area where someday someone may do some research. If there was only some way we could tell who is susceptible and who is not, how much better off the employees would be.

Anyhow we had a problem - - what were we going to do about it?

Our first approach was to try to eliminate dust in the foundry - but frankly no one knew how to go about this. Then we started in pre-war production and with the exception of the start of a respirator program nothing was done.

In 1943 our Plant Manager heard about Aluminum Therapy and became interested. There was no proof at the time that Aluminum Therapy would prevent silicosis but he was assured by doctors that it would not do any harm. In 1944 we became the first foundry in the United States to administer Aluminum Therapy. Now I am not going into the pros and cons of Aluminum Therapy but let me tell you some of the non-medical results of the program.

Before we could receive a license to give Aluminum Therapy it was necessary for us to have an Industrial Hygienist make a dust survey of our plant and I'll be frank, I don't think there was a person in the plant, including yours truly, who knew anything about a dust survey. Besides the actual survey, we received some advice as to what could be done with some of our dust problems.

Next the Medical Director of the McIntyre Foundation held meetings with all our supervisors and explained the whole subject of silicosis. Now our supervisors had some knowledge of this disease and realized the importance of trying to eliminate dust and if that was not possible, of seeing that not only their men but they themselves wore respirators.

There were many other results such as using wet water to spray passageways and the introduction of new shake-out machines with adequate exhaust systems to eliminate the dust at its source.

Now this may sound as if I am wandering off of my subject but these were all the results of starting a periodic x-ray program.

I cannot tell you the number of people who have been referred to their family doctors because of some condition which we found in our pre-employment physical examination. I can remember one young family man who was hired for a job in our office and whose pre-employment examination showed a lung condition. When told he could not come to work, he raised holy ned and insisted that our doctor was wrong - there was nothing wrong with him and he knew it. He insisted on seeing our doctor and I arranged a meeting. Our doctor finally persuaded him to see his family doctor. I don't know what was wrong with the man but I do know he had a serious operation and spent a number of years in Arizona - I saw him the last time I was in Chicago and now he thanks me for what we did - because he would not be alive today.

In the plant which I have been discussing, employees working in a silica hazard are x-rayed every year - - employees working in other areas and the office, every three years; when we started, it was every two years. The only exception to this is where the Roentgenologist asks for an x-ray at a certain time. During one of these periodic x-rays our Roentgenologist found something in the x-ray of one of our top superintendents. He was called in by the plant physician and advised to see his family doctor. His doctor asked for the series of x-ray pictures which we had. We always allow the employee's doctor to review the chest x-ray which we have taken. This superintendent was sent to Mayo Clinic, was operated and is still working today. Thus, we have an important key man working today - his family has their father with them. They and we would not have had him if it had not been for our periodic x-ray program.

In this talk I have tried to give your our experience with pre-employment and periodic x-rays. Although the incidents which I have related to you are based on experiences in only one plant; I believe they could be duplicated in almost every shop that uses pre-employment and periodic x-rays.

As I have indicated, the results are both direct and indirect. Direct, in the detection of lung disorders, timely referral to family physicians and prevention of more serious disorders, even the saving of human lives. The results are indirect in that they made everyone aware of the hazards and encouraged them to reduce or where possible to eliminate them.

We would like to know how many lives we saved in that plant by pre-employment periodic x-rays and the awareness of hazards that they aroused in us and our resolution to something about them. If we saved merely one life, the cost would have been more than justified.

CAN A UNION ACCEPT A PERIODIC X-RAY PROGRAM? A WORKING MAN'S VIEW OF HEALTH EXAMINATIONS

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The question "Can a Union Accept a Periodic X-ray Program?" implies that unions may have some reservations about the value of health examinations. Actually, unions have been in the forefront of obtaining health services for the people, through both collective bargaining and legislation. The great majority of all group voluntary health insurance in the country today results from the efforts of the labor unions.

And the unions want more health services. Increasingly, they are recognizing the value of, and demanding, preventive services and high quality medical care. Witness the recent resolution of the United Steelworkers of America supporting the development of prepaid group practice comprehensive service plans. The United Mine Workers of America and other unions also endorse this type of program.

Corporations, too, value these health services. They are contributing financially to their development within the frame work of negotiation with the unions. Most of the substantial corporations also require, and pay for, periodic examinations of their executives.

There is basic agreement on the value of health services. Where is the trouble? The trouble lies in the occasional use by management of the findings of x-rays or other health examination procedures, for purposes that are more economic than medical. For example, an applicant for employment is rejected, or an employee is discharged because of some finding which may be positive, or merely suggestive, of disease. Or the company fails to inform a worker or his personal physician of a finding which should receive medical treatment.

These actions are understandable. Management is anxious to avoid workmen's compensation claims or other liabilities. However, frequently the physical finding does not contraindicate working in a given job. Or the finding may be a signal for stronger preventive measures for a certain occupational hazard and/or treatment for the injured individual.

The issue basically is economic, not medical. When the physician allows his findings to be used thus for economic ends, he is violating the Hippocratic ethic of concern first for the patient entrusted to his care.

How can unions and employers resolve this problem? There are doubtless many approaches worth exploring.

The problem would be greatly simplified, if we could assume that all available scientific knowledge to prevent occupational disease is promptly implemented in the workshop. If this were so, there would be no question of the safety of many workers continuing in jobs where today there are health risks.

Not being able always to make this assumption, we must strive to find other solutions that will satisfy management's fear of liability and the worker's fear of the medical examination, as a weapon that threatens his security.

First, with respect to the pre-employment examination. Should the x-ray reveal something suspicious and the job is dusty, are not management and management's physicians obligated to inform the worker or his designated physician of the findings, so that the individual may obtain further diagnosis, treatment, and rehabilitation?

With respect to the already employed worker in whom an examination reveals something of occupational, non-occupational, or mixed etiology, is there not even a stronger obligation to inform the worker and his doctor of the facts, so that he may receive whatever care and compensation may be indicated? Many a good worker with many more years of productivity may thus be salvaged to the ultimate benefit of both employee and employer.

Some years ago, a union and an employer in a dusty trade culminated many years of unprotected pneumoconiosis hazard by a collective bargaining agreement which provides as follows:

> "The Company shall make every effort to have available the results of the periodic examination and x-ray checks by the Doctors. The results shall be made available to the employee examined or to the person designated by him upon receipt of a written request of the employee."

Another type of approach is an impartial medical board such as is used in some workmen's compensation programs. Here, an impartial group of physicians, perhaps on the staff of a governmental agency, would pass on the ability of a man or woman to work at a given job. There would be assurance that the tests and their interpretation are objective. The injured worker would be given information, medical care, and where indicated, compensation.

A broad social measure that might help to reduce excessive litigation under workmen's compensation would be the equalization of benefits for disability whether occupational or non-occupational in origin. Sweden has such a system. But this would have limited feasibility in the United States at present, since there is no universal system of non-occupational disability benefits, and the workmen's compensation systems, state by state, are so chaotic.

One of the most hopeful possibilities lies in the increasing development of the prepaid group practice comprehensive medical care plans. These plans are largely fostered by union and consumer groups, and in some cases, initiated by unions in conjunction with management. In many instances, management is paying the bill through negotiated agreements.

These programs emphasize prevention within the framework of comprehensive services. They provide continuity of care. They are concerned that medical care be of good quality.

They have thus far done little or nothing in occupational medicine, but they cannot avoid seeing these problems. The artificial separation of occupational from non-occupational health services imposed by tradition and by the legal and economic barriers inherent in the state workmen's compensation acts has retarded progress here.

Yet these plans offer a great potential for providing high quality medical protection to the working man and woman. In the long run, this would benefit industry and labor.

The proposition before us - the value of periodic health examinations for workers - - is elementary, indeed primitive. That the accomplishment of it requires discussion is symptomatic of how far we yet have to go in occupational health. If we want, badly enough, every working person to have this, then ways will be devised to meet this need. With increasing awareness of the value of health services, we can be optimistic about realizing the goal of preventive medicine for everyone.

A PERIODIC X-RAY EXAMINATION PROGRAM

COMPULSORY OR VOLUNTARY – MANAGEMENT'S POINT OF VIEW

F. R. Barnako, Manager of Compensation & Safety
Bethlehem Steel Corporation, Bethlehem

The topic which I have been assigned, management's viewpoint of the relative merits of a compulsory or voluntary periodie x-ray examination program, actually poses a rhetorical question. Which is preferable, a compulsory or a voluntary program? To me the answer is obvious and could be given in one word. But, since I have been given the opportunity to talk more at length, I shall broaden the scope of my remarks, limited by the guideline that they shall be pertinent to the over-all topic of this Conference.

The over-all program for this meeting is a broad one since we are in an area that is constantly growing, with new studies and knowledge being developed daily. In fact, it is interesting to note that this field is now responsible for what is currently the longest word in the Webster unabridged dictionary - pneumonoultramicroscopicsilicovolcanoconiosis (pneumono-ultra-miero-seopic-silico-volcano-coniosis), a 45 letter word, which, in this day of record keeping easily out-distances the former 28 letter record holder, antidisestablishmentarianism.

Before comparing the merits of a compulsory or a voluntary plan, we should first analyze a periodic x-ray program per se, so that we will have some idea as to its merits and limits and will be in a position to better know its values and deficiencies. Such a plan, by definition, encompasses the taking of chest x-rays of a class of individuals under study at set, specified intervals over a period of time which could be a few weeks or several years. We are dealing, of course, with pneumoconiosis, not only silicosis or anthraco-silieosis, but other forms as well. Experience has shown that industrial dust diseases may develop in a year or two or may not develop until after periods of long exposure, measured in years, five, ten, fifteen or twenty. Due to differences in density between accumulations of the dusts and lung tissue, or due to the reaction which the dusts may cause in the lungs, roentgen examination is of assistance in detecting and diagnosing the conditions and in tracing their development. Experience has designated the various industries and oceupations which have potential health hazards, including, among others, coal mining and foundries. We have also over the years developed guidelines as to the concentrations of various dusts which may constitute a hazard, particularly through the work of the American Conference of Governmental Industrial Hygienists. With the knowledge gained it is apparent that the institution of a periodie x-ray program for detection of pneumoconiosis should be limited only to those industries, and those specific occupations within the industries, in which employees will be subjected to a potential hazard of significant proportions. Other areas can be eliminated, thus avoiding the unnecessary expenditure of time, energy and money, and the accumulation of data that will be essentially negative.

What significance will the x-rays have? Thousands undoubtedly will portray what the roentgenologists classify as normal lungs. Since we will be dealing with individuals who are in exposures, known to be hazardous, others will show some evidence of pneumoconiosis, including some with the fibrous nodules in the parenchyma of the lung descriptive of silicosis. However, taken alone, the roentgenograms may or may not be signifieant. It is at this point that we should analyze the fundamental purposes of a program. The broad goal is the prevention of pneumoconiosis. In the occupations we have under observation, this is a major problem; one that presents a challenge that can be combated only by the combined resources of the industries themselves, armed with the know-how and scientific knowledge developed by the mining engineering, medical and industrial health enginecring professions. However, x-rays represent only one, albeit a useful, tool. Their maximum significance, at least as far as the individual subject is concerned, comes only in conjunction with other studies of the individual, but they can and do serve a highly useful function even taken separately. For instance, in a broad program, where early roentgen changes are disclosed, they can perhaps serve to pinpoint critical work areas. They can assist in detecting individuals whose susceptibility, whatever the cause, may be remarkably lower than that found in the average work group. They constitute or contribute to evidence as to whether a problem in fact exists. They give the surveyors an opportunity to observe when and how soon the first and earliest lung changes may occur.

All of these, it must be acknowledged, are meritorious features of a periodic program. In addition, purely as sidelights, but of tangible value, is the fact that such a program will also assist in ferreting out persons who may have heart conditions, tuberculosis or carcinoma.

If the purpose of the program is to single out those individuals who are disabled as a result of a hazardous exposure, we know that x-rays alone are not sufficient. There are many studies which show that there is no true correlation between pulmonary symptomatology and the roentgenographic findings. The existence of disability, that is, the impairment of physical function, and its cause, can be accurately determined only in the light of the individual's occupational history, his medical history, and other examinations, such as lung function studies and blood oxygen saturation studies, combined with a chest roentgenogram. It is only after an over-all examination, and these studies, that a true evaluation can be made of the disability of the subject. This, incidentally, is the question of most concern to the individual workman. Our goal is to prevent the conditions which cause pneumoconiosis, a venture in which each employee may heartily join, but, in addition, the workman has the very personal concern as to what effect these exposures may have, if any, on him.

A recent survey which had as its purpose the determination of the prevalence of chronic bronchitis among industrial workers in Detroit is of interest. (1) Of the men studied, 544 were individuals who had been subjected to a silica hazard for more than 20 years. Of this group, 404 had normal chest roentgenograms while 140, while still working, showed roentgen evidence of silicosis. No effort was made to gauge the extent of disability of the subjects. Other studies have been made, however, which attempted to demonstrate the relationship, if any, between x-ray evidence and respiratory findings. Medical literature indicates that some of these studies show a direct relationship, (2) others have been unable to show any relationship, (3) and some surveys have actually reported a higher prevalence of respiratory symptoms in workers without x-ray evidence of pneumoconiosis than in those with such evidence. (4) The results, at least to this observer, are inconclusive.

If one of our purposes is to make disability evaluations, it is apparent that a program which contemplates the use of periodic x-rays alone is grossly inadequate. Other tests have to be made and the effectiveness, usefulness or significance of the respective studies is a matter for determination by the medical profession. Suggested tests include maximum breathing capacity, vital capacity, timed vital capacity and arterial blood oxygen studies, among others, with the relative merits of each once again a matter for the medical profession. (5) Chest roentgenograms are of considerable assistance and are a necessary device, but, to be given their real worth, their evidence must be taken in conjunction with the other studies. Although the costs of a periodic x-ray program alone may be relatively moderate, the costs of a full-scale examination program, with the necessity of setting up area centers, plus equipping and manning them, will not be unsubstantial.

Further, in a periodic x-ray program consideration should be given to the interval at which the re-examinations are to take place. In Ontario, under its Mining Act, this is apparently done on an annual basis. Under the proposed Pneumoconiosis Prevention Act, examinations are to be given every 3 years for workers with less than 10 years of mining employment and every 2 years for those with more than 10 years employment. Perhaps the need for such regularity can some day be shown; perhaps data will be developed to show the merit of automatic re-examination periods, whether on a less than annual, or an annual, 2, 3, 5, or 10 year basis. However, until such proof is forthcoming I submit that it is more scientific, and more productive to institute a re-examination program based upon the needs of the individual. The program should be under the guidance of a physician who can take into consideration the specific history of the man's exposure, the clinical findings and the x-ray evidence and who can make a comparison with other workers who have had a similar exposure. The physician can then make an intelligent determination as to the re-examination interval.

Up to this point I have touched upon the pros and cons of a periodic x-ray program, whether on an isolated basis or in conjunction with other studies. We are now faced with the issue - - shall such a program be mandatory or voluntary. To my mind the freedom and lack of compulsion that would attach to a

voluntary program would, of course, be prefcrable. On the other hand, the mere fact that a program is mandatory does not render it inherently objectional. It is in the lack of flexibility that a mandatory program may become objectionable. Rigidity in the scope of the program, both as to the areas and occupations to be covered, before the need is proven, is objectionable. Specifying the interval for re-examinations is objectionable. Mandatory continuation of a program after the need thereof has been disproven is objectionable.

A voluntary program has the virtue of fluidity. It can be adapted progressively. It can be broadened with the supply of the necessary equipment and manpower. It can be applied with intelligent discrimination to the men in those areas and occupations whom we know by experience are in significant exposures. It can be enlarged to cover questionable areas. It can be terminated at will when the need no longer exists. The interval for re-examinations can be set on a definite basis, or it can be staggered or telescoped based upon the need as determined by the supervising physician. Men in an acute exposure can be examined on a less than annual basis. Men in a peripheral exposure can be examined on a 5 or 10 year basis. Individuals whose history and clinical findings are unique can be re-examined at any interval deemed medically prudent by the examiner. Assuming the programs are prosecuted with equal diligence, it is the voluntary program, with its greater flexibility, that is capable of being meaningful.

A real question is raised, however, whether the answer to the pneumoconiosis problem lies in an x-ray program. Fundamentally, from our industrial health engineering experience we know that in working with any dust, gas or fume, our best approach is to attack the source by engineering controls. Initially we look to isolation of the source; secondly, control of the hazard; and thirdly, equipping the exposed men with protective clothing and equipment. Following this proven approach our efforts should be directed to the institution of preventative measures which would get to the source of the responsible causative agents. It is axiomatic that silicosis is caused by free silicon-dioxide. The Pennsylvania Occupational Disease Act in its schedule of diseases lists silicosis or anthraco-silicosis in any occupation involving direct contact with handling of, or exposure to dust of free crystalline silicon-dioxide (SiO_2). We have known for a long time that this is a hazard in the mines. The extent of the hazard, however, varies from mine to mine; it varies with the occupations in the mines; and it is dependent upon the type of mining processes used. Mining processes have developed considerably during the course of our industrial history, bringing with them new benefits but also causing some new problems. Essentially, we are confronted with the problems of controlling the amount and concentration of the dusts. Methods are constantly under consideration in the industry for doing this by improving ventilation, changing the system of ventilation, the use of water sprays and the use of new and approved type dust respirators. It is essential that efforts be continued to develop improvements in this area and that new methods, once of proven value, be instituted if practical and reasonable.

Before I close this paper I would like to comment upon the proposed Pennsylvania Pneumoconiosis Prevention Act which, in effect, would provide that no person is to be newly employed in a mine unless he is the holder of a certificate stating that he is fit for work. An examination would be made of new applicants for employment in the mining industry as well as all persons now working in a mine. New applicants would be rejected for employment if they had any evidence of present or past lung disease, heart disease, epilepsy or history of fits, marked disability from previous injury or obvious poor general physical condition. Re-examinations would be required every 3 years for those with less than 10 years of mining employment and every 2 years for those with more than 10 years of employment in the industry. The proposed act would render ineligible for further continuing work any employee, who on a re-examination, showed evidence of active tuberculosis.

The Pneumoconiosis Prevention Act apparently is based upon the Ontario Silicosis and Mining Acts. These acts together provide that any employee engaged in an occupation involving a silica exposure is required to undergo a medical examination. It is further provided that he shall not be employed in a dust exposure unless he is the holder of a certificate, good for one year, upon a finding that he is free from diseases of the respiratory organs and is otherwise fit for employment in a dust exposure. The Mining Act further provides specifically that tuberculosis is a ground for denial of the renewal of a certificate.

However, it is also inherent in the Act that an employee must also be free of respiratory disease to be entitled to a renewal. We, of course, are confronted with a serious problem in Pennsylvania in that we now have over 7,000 persons on our rolls who have been determined to be totally disabled as a result of silicosis, with the costs of compensation payments being paid to these persons in excess of 16 million dollars annually. The proposed Pneumoconiosis Prevention Act does not answer this problem. Actually, its preventative features are questionable. It would preclude employment of new applicants from working in the mines who had heart, lung and other conditions. But once they had obtained employment they would remain on the rolls, regardless of their physical condition or exposures unless active tuberculosis was found. Periodic x-rays and examinations would be made but other than making interesting personal medical history, it is not clear what real purpose would be served. We must be certain that the legislative methods which we adopt to control or prevent the pneumoconioses fit the situation in Pennsylvania. It is important to remember that the Ontario Silicosis and Mining Acts in their total application are much different from our Acts. The compensation administrators have complete control over medical treatment, rehabilitation and employment. It is error, therefore, to attempt to adapt parts of their practice to the State of Pennsylvania.

It is my understanding that the advocates of the Pneumoconiosis Prevention Act contemplate that following examination of new applicants or employed miners which reveals one of the conditions stated in the Act a program of rehabilitation, including job re-assignment, could be instituted. While this may be desirable the application of such principles is rendered even more difficult under Labor-Management Agreements which preserve the seniority of the worker. Seniority encompasses three factors, i.e., length of service, relative ability and physical fitness. Those who are familiar with the application of industrial agreements realize that it is not an easy step to transfer an employee from one job classification to another nor to refuse him employment even though the employee may wish a job transfer. Such procedures affect not only the employee involved but others as well. Further, if rehabilitation and job transfer are to be undertaken or considered not only in cases of active tuberculosis but those of other chest diseases, heart disease, epilepsy, etc., it is quite probable that the problem would be on such a wide scale as to seriously disturb not only seniority but employment.

There is one further aspect that I would like to touch upon. Assuming that a given individual after a medical examination is denied a certificate to continue working in the mines and assuming that there is no other job to which, as a practical matter, he can be transferred, or that for reasons of his own he refuses the transfer, should and can this individual be denied the right to continue work, even though a medical examination has disclosed the presence of a respiratory condition and even though all persons, including the employee, know that further work in the environment will have a deleterious effect upon his condition? Apparently in Ontario an employee has no right to continue in the employment once he loses his certification, however, here in the United States court decisions interpreting the Fifth and Fourteenth Amendments of the Federal Constitution have held that an individual shall not be deprived of his life, liberty, or property, without the process of law.

Absent any considerations of Labor-Management questions, the Supreme Court has stated that the liberty of pursuit, the right to follow any of the ordinary callings of life, is one of the privileges of a citizen of the United States. (6) The Supreme Court of Oregon has held that an individual has a right to earn a living by following any ordinary occupation. (7) The California Supreme Court has noted that this right enjoys the guarantee of the Fourteenth Amendment. It is true that this right is limited by the police powers of a state if it affects the health, safety and welfare of others. (8) But here we are not involved with communicable diseases, other than active tuberculosis. (9) May a state, therefore, legislatively require certification as a condition of employment in the mining industries? I submit that as a question; I cannot presume to predict what the Supreme Court's answer would be.

Thank you, it has been a privilege to be invited to address you here today.

REFERENCES

(1) Brinkman, Geoffrey L., and Coates, Jr., E. Osborne: The Prevalence of Chronic Bronchitis is an Industrial Population, Vol. 86, No. 1, The American Review of Respiratory Diseases, July, 1962.

(2) Rogan, J. M., et al.: Pneumoconiosis and Respiratory Symptoms in Miners at Eight Collieries, British Medical Journal, May 13, 1961.

(3) Newell, D. J., and Browne, R. C., Journal Fac. Radiology, 1955.

(4) Gilson, J. C., and Hugh-Jones, P.: Spec. Rep. Ser. Med. Res. Council, No. 290, 1955.

(5) Motley, H. D.: The Use of Pulmonary Function Tests For Disability Appraisal: Including Evaluation Standards in Chronic Pulmonary Disease, Presentation Annual Meeting, Am. Col. Chest Phys., June 6, 1952.

Lloyd, Jr.,T. C., and Wright, G. M., Evaluation of Methods Used in Detecting Changes in Airway Resistance in Man, Am. Rev. of Resp. Diseases, Vol. 87, No. 4, April, 1963.

(6) Butchers' Union v. Crescent City, 111 U.S. 756, 28 L. ed. 585 (1884).

(7) Kenji Namba v. McCourt, 204 P. 2d 569 (Sup. Ct. Ore. 1949).

(8) Bautista v. Jones, 155 P. 2d 343 (Sup. Ct. Cal. 1945).

(9) Dasch v. Jackson, 183 A. 534 (Ct. App. Md. 1936).

PROBLEMS WHICH MAY OCCUR – UNION'S POINT OF VIEW

Joseph Yablonski, President, District Five
United Mine Workers of America, Pittsburgh

The United Mine Workers of America is always prepared to give serious consideration to any program which would in some measure result in the improvement of the welfare and economic well-being of its members. A pneumoconiosis prevention program would naturally concern us greatly since this disease has been an ever present plague in the coal industry.

The vital factor around which an effective pneumoconiosis prevention program should revolve would be the elimination of the harmful dusts which produce the disease; however, automation in the coal industry with its high speed continuous miners and roof-bolting methods together with other automated operations results in greater hazards than at any time in the mining industry.

Before we can seek the cooperation of our members in any pneumoconiosis prevention program which would subject them to periodic physical examinations and medical supervision we must have adequate assurance; first, that the coal industry will come up with an effective dust elimination program and; second, that liberal compensation, rehabilitation and medical care will be provided to those who become afflicted with silicosis through exposure to the obnoxious dusts of the industry.

Under the draft of the proposed Act new entrants to the coal mining industry may be denied medical certificates because of physiological impairments which would not in any way aggravate or produce pulmonary occupational disease. Denial of medical certificates to these men would certainly not be justified.

It would not be just, or equitable, to deny a health certificate to a person who had devoted his lifetime to the coal industry and was temporarily displaced by automation or by the shutting down of a plant.

Under the suggested legislation a health certificate could be issued only to persons who could meet a standard of physical perfection; thereby, denying employment to persons who had depended on the coal industry for their livelihood and who had earned equity in the form of pension benefits, death benefits, hospital and medical care under the United Mine Workers of America Welfare and Retirement Fund.

Periodic examinations and medical supervision of miners already employed in the coal industry may arouse in our members a feeling of antagonism and distrust. Based on past experience miners fear such examinations believing that they are used not for the miners' benefit but only to burden miners with additional worries and anxieties.

One problem we may face would be how miners are handled after they have gone through a periodic examination and, perhaps, some lung involvement (other than active tuberculosis) is diagnosed. Would there be pressure, applied directly or indirectly, from the Commonwealth or maybe from the company to force the individual to leave his employment.

Would reports of medical examinations be used only by the State to help the individual or would they, even if it be by accident, be used for purposes which would result in economic hardship to the miners through loss of income and no comparable compensation benefits.

To embark on an extensive program of periodic examinations of employed miners requires that much more attention be given to the question of what is done after examinations are made. It is important that the question of availability of these medical reports, the purposes for which they are to be used, and, also, by whom they are to be used is clearly defined.

The United Mine Workers of America as an organization will not agree to any mandatory physical examinations of the employees, whether they be pre-employment or intermittent examinations, as long as industry's problem of keeping down the dust is unsolved.

We are further reluctant to agree to any form of legislation which would refuse employment in the coal industry to men who may have some insignificant physical disability which is not normally reflected in any industrial disablement.

We, also, feel that employees of the coal industry who are removed from the industry because of industrially acquired silico-tuberculosis should receive compensation so long as they remain totally disabled from such disease.

EXPERIENCES WITH PARTIAL COMPENSATION DISABILITY EVALUATION IN SILICOSIS

William C. Stewart, M.D., Chairman
West Virginia Silicosis Medical Board

Silicosis was recognized as an important industrial disease in West Virginia at the time of the Hawks Nest disaster in 1931 and 1932 and as a result of this experience a West Virginia Silicosis Law was enacted by the Legislature and became effective in 1936. The West Virginia Silicosis Medical Board was established as a sub-division of the Compensation Commission, and the technical and medical features of the Law were set down. Harmful exposure to silicon dioxide was defined and the disease silicosis was classified in three stages for purposes of compensation. First Stage Silicosis was defined as the earliest detectable signs of silicosis without associated disability. Second Stage Silicosis was defined as silicosis resulting in impaired capacity to work of any degree less than total and permanent disability. Third Stage Silicosis was defined as silicosis resulting in total and permanent disability. Except for some variation, due to changing interpretation, the Law remained unchanged until July 1, 1961.

The Silicosis Medical Board is composed of three physicians appointed by the Compensation Commissioner who is required to appoint one x-ray specialist and two clinicians to the Board. The Board makes non-medical findings relating to harmful exposure to silicon dioxide on occasion but its primary responsibility is to find whether or not Silicosis is present and, if so, the stage of the disability. Changes in the Law which became effective on July 1, 1961 required that the Board continue to recognize First Stage or non-disabling silicosis and Third Stage or totally and permanently disabling silicosis but that degrees of disability less than total be identified as to the per cent of disability resulting from the silicosis found to be present. Determination of the stage of disability produced by silicosis was at times difficult under the Old Law but under the New Law the difficulties were multiplied. Figure I shows the points which have been found helpful in the determination of disability.

Figure I Silicosis Disability Evaluation

1. History
   A. Industrial
   B. Medical

2. Physical examination including exercise test

3. X-ray

4. Pulmonary Function Testing

An industrial history of probable exposure to harmful quantities of silicon dioxide is essential if the diagnosis of silicosis is to be made by x-ray of the chest since the changes in the x-ray are often typical but are not pathognomonic. Recognition of the earliest diagnostic changes of silicosis is particularly difficult and controversial. It is generally agreed upon that silicosis may be present without pulmonary disability and at times the x-ray changes of silicosis may be moderately advanced and still not be associated with pulmonary disability. The patient's history, both industrial and medical, may provide a good background for the examiner in his efforts to ascertain whether or not pulmonary disability is present. It is of interest whether or not the claimant continues to be employed and, if so, whether or not his work appears to be producing more pulmonary symptoms than was previously the case. Especially important is a determination from the history, in so far as it is possible, whether or not standard effort involved in performing a regular duty is producing more disability or pulmonary symptoms than it did one to two years previously.

The medical history is also important in evaluating the patient's altered response to exertion and while it must be evaluated with great caution, it may be a very useful bit of evidence in reaching a decision as to whether pulmonary disability has developed. The physical examination is particularly valuable in that it may assist in the identification of objective evidence of disability, which is particularly important in those being examined for compensation purposes. The physical examination is directed first to the identification of conditions which might produce evidence of pulmonary disability of a non-silicotic nature, such as heart disease, asthma, recurrent bronchitis, or pneumonia. Physical examination is of more specific assistance in determining whether or not pulmonary disability exists and this becomes largely a matter of attempting to identify the presence of emphysema. Experienced examiners may be able to identify changes in the contour of the chest, utilization of accessary muscles of respiration, retraction of intercostal spaces over the lower parts of the chest, and changes in the breath sounds which would indicate an obstructive interference with the free flow of air in the respiratory passages.

Numerous published observations are on record indicating that the x-ray of the chest can not satisfactorily be used as a guide to the presence of pulmonary disability or to the degree of pulmonary disability, if present. While recognizing the truth of this position, we have found that the x-ray of the chest, if used cautiously, may be of real value in identifying the presence of disability and the cause of disability, namely, emphysema. In a series of cases studied by the West Virginia Silicosis Medical Board the x-ray specialist member of the Board independently estimated the presence or absence of pulmonary disability on the basis of the x-ray. Subsequently, after decisions had been made as to the presence of disability on all the available medical evidence, it was found that the opinion of the x-ray specialist had been correct in eighty-seven per cent of the cases studied. It is extremely difficult, when viewing an x-ray which shows extensive changes of silicosis, perhaps including conglomeration, flattening of the diaphragms, increase in the hilar shadows, and well marked evidence of emphysema at the lung bases not to be influenced by these changes in making a judgment as to whether pulmonary disability is present or not.

Under the Silicosis Law, which became effective July 1, 1961 and required the Silicosis Medical Board to find the per cent of disability in those disabled by pulmonary silicosis and not totally and permanently disabled, it became clear that objective evidence of pulmonary disability would be of paramount importance. This led, naturally, to the use of pulmonary function testing, which had been under study by the Board for several years, and this testing then became a regular feature of the examination conducted by the Board. It must be mentioned that claimants being examined for purposes of compensation must be evaluated extremely carefully. It is quite natural that some of these claimants will make less than a maximum effort in their performance of any type of compliance test which may be used. With this in mind the laboratory and the personnel in the laboratory performing the tests becomes especially important. All testing has been done for our Board over a period of more than three years by the same chief technician, who now has great experience in determining whether or not the patient's motivation, co-operation, and compliance has contributed to a satisfactory test. In the last 2,356 cases examined by our Board and found to have silicosis, we have followed a policy of having the chief technician record whether or not the test was thought by him to be entirely satisfactory, partially satisfactory, or totally unsatisfactory. The results are recorded in Figure II.

Figure II Silicosis Disability Evaluation with Pulmonary Function Tests

October 1, 1961 to October 12, 1964

Satisfactory Tests	1,946	82.7%
Partially Satisfactory Tests . . .	187	7.95%
Unsatisfactory Tests	223	9.35%
Total Claimants examined	2,356	

It is our opinion that pulmonary function testing, if it is to be used in the evaluation of pulmonary disability for purposes of compensation, must be viewed critically in this fashion.

Pulmonary function tests may be performed in many ways and a wide battery of tests are now available which measure almost all the parameters of pulmonary function. Some of these tests are rather involved and require sampling of venous and arterial blood in addition to time consuming methods for gas analysis. This type of testing has its place but with the claimants being examined by our Board we soon learned that the tests would have to be the simplest and most easily performed and, especially, that they be tests which could be repeated. In time, we came to depend on the timed vital capacity and the maximum breathing capacity and the walking ventilation and made an effort, whenever possible, to repeat these tests three times with adequate resting periods between the performance of the test on all claimants. We have used as our predicted value for the one second timed vital capacity 75 per cent of the actual vital capacity but, in fact, have learned that the more realistic figure for the one second timed vital capacity is 70 per cent of the actual figure, and we now use it as the critical figure. Patients with a timed vital capacity in the first second of 67, 68, or 69 per cent of the actual figure for the total vital capacity have been found usually to have some pulmonary disability. When the figure for the one second timed vital capacity is reduced to 65 per cent of the actual vital capacity, the disability has generally been found to be more than slight and in the area of 20 to 30 per cent loss of pulmonary function. As regards the 3 second timed vital capacity, we have found that the critical figure appears to be 95 per cent of the actual vital capacity. When the 3 second timed vital capacity has been reduced to 92, 93 or 94 per cent of the actual vital capacity, 20 to 30 per cent loss of pulmonary function has generally been found. In our series of patients, the MBC has not been found consistently abnormal beyond the commonly accepted variations allowed for this test until the timed vital capacities have been found considerably reduced. When the maximal breathing capacity has been significantly reduced, we have generally found claimants to be suffering from pulmonary disability of at least 30 to 40 per cent. We have continued to use the walking ventilation test and on occasion find it helpful but there has been a good deal of inconsistency in our results with this test, and we do not yet know what its final place will be in the testing which we will continue to do.

Utilizing the methods which have been referred to, we have now had extensive experience in the evaluation of pulmonary disability due to silicosis in terms of partial disability. There are many problems which continue to be met and on some points we are not entirely satisified with our efforts to identify partial pulmonary disability. Figure III shows the results obtained by our Board in the last 1,000 cases of silicosis examined up to a very recent date.

Figure III Results of Silicosis Disability Evaluations

March 1962 to October 1964

First Stage Silicosis	474
Second Stage Silicosis	
10% disability	4
15% disability	200
20% disability	123
25% disability	29
30% disability	57
35% disability	4
40% disability	33
45% disability	1
50% disability	24
60% disability	14
Total disability (Third Stage)	37
Total Claimants Examined	1,000

It will be recognized that the Board had some difficulty in determining minimal pulmonary disability in that the first point at which slight degrees of disability was thought to be recognizable, except for a few cases, was 15 per cent disability. A considerable number of claimants were found to have 20 per cent pulmonary disability and a few to have 25 per cent disability; then, it appears that the Board had some difficulty in recognizing increments of disability of less than 10 per cent. Also, it becomes evident that claimants thought to be more than 60 per cent disabled due to silicosis were, generally speaking, considered to be totally disabled.

MANAGEMENT'S VIEW ON PARTIAL COMPENSATION

James P. Robinson, Esquire
Clarksburg, West Virginia

1. Management's view generally concerning partial compensation for silicosis.

From my experience in workmen's compensation cliams, generally representing thc employer, I have found the employer's view to be - that any disability caused by an injury that is received by an employee in the course of and resulting from employment should be fairly compensated. This position is simple to state, but it is difficult to achieve. In what amount and by what procedure compensation shall be made, of course, is for the legislatures of the respective states to decide, as a matter of policy, after full study.

It thus appears that the employer should have no different view than the employee or the state, on this subject, being that an injured workman should be fairly compensated. In view of this observation, I will not speak in terms of "management's view", but rather, "my view" as an attorney who has mainly represented employers in this type of case.

As I understand it, this conference concerns anthraco-silicosis, rather than the whole field of pneumoconiosis, as the latter term, pneumoconiosis, includes a number of pulmonary diseases or conditions, such as aluminosis, tobaccosis, asbestosis, and others, as well as silicosis. Anthraco-silicosis comprehends troubles resulting from deposits in the lungs of both coal dust and silica. The applicable statutes of West Virginia have to do simply with silicosis, with some reference to tuberculosis. I don't mean to be unduly pre-occupied with terminology, but I want to make it clear that the statutes which I will discuss refer to silicosis caused by the exposure to silicon dioxide dust, only, whether or not accompanied by tuberculosis of the lungs. Of course, it is realized that in a coal mine, anyone exposed to silicon dioxide undoubtedly will also be exposed to coal dust.

In West Virginia, we also have statutes comprehending occupational diseases other than silicosis, but I will not go into those statutes.

At this point, it should be observed that Pennsylvania and West Virginia base their respective methods of compensation payments on different theorics. As I understand it, Pennsylvania bases payments on the actual loss of earnings; whereas, West Virginia bases payments on percentage of disability.

Although I will discuss the provisions of the statutes of West Virginia governing compensation for silicosis prior to 1961, and the amendments adopted in 1961, there are some provisions that are common to both periods.

The basic common provisions arc that compensation shall not be payable for silicosis, or death resulting therefrom, unless, in the State of West Virginia, the employee has been exposed to the hazard of silicon dioxide dust over a continuous period of not less than 2 years during the 10 years immediately preceding the date of his last exposure to such hazards; that the application for benefits shall set forth the name of the employer or employers and the time worked for each, and the Director may allocate to and divide any charges on account of such claim among the employers by whom the claimant was employed for as much as 60 days during the period of 2 years immediately preccding the filing of the application; and that the allocation shall be based upon the time and degree of exposure with each employer.

2. Stages of silicosis and benefits to be paid therefor, under the statutes prior to 1961.

Prior to 1961, there were three stages of silicosis:

In the first stage, when it was found that the earliest detectable specific signs of silicosis were present, whether or not the capacity to work had been impaired;

In the second stage, when it was gound that definite and specific physical signs of silicosis were present, and the capacity for work had been impaired by the disease;

In the third stage, when it was found that the employee had silicosis which resulted in total permanent disability, whether or not accompanied by tuberculosis of the lungs.

Compensation paid for the first stage, was the sum of $1,000.00, which was a final payment and was a full release for any claim thereafter for silicosis;

Compensation for the second stage was the sum of $2,000.00, which was a final payment and full release for compensation thereafter for silicosis;

For the third stage, compensation was paid in the same manner and at the same rate as provided for other cases of permanent total disability; and if the employee died from silicosis within six years from the date of his last exposure, and the Director had determined at the time of the original award that the employee was suffering from silicosis in the third stage, then his beneficiaries would receive normal death benefits.

3. Stages of silicosis and benefits payable therefor, under the 1961 statute.

In 1961, the statute was revised, so as to provide for only two stages, rather than three.

The first stage remains the same, that is, it exists when there is a finding that the earliest detectable specific signs of silicosis are present, whether or not the capacity for work has been impaired;

In the advanced stage, when it is found that definite and specific physical signs of silicosis are present, and the capacity for work has been impaired by the disease.

Compensation for the first stage remains the same, being the payment of $1,000.00, as compensation in full and releasing all further claims for silicosis;

In the advanced stage, the percentage of permanent disability is to be detmined by the Director "in accordance with the facts in the case and with the advice and recommendation of the Silicosis Medical Board", and compensation is to be paid in the same manner and at the same rate as in other cases of permanent disability, except that the determination of the percentage of disability and acceptance of such payment shall be final, and no further compensation shall be made for silicosis.

Compensation for permanent partial disability is computed by determining the percentage of disability, as compared to total disability. If the percentage is from 1 to 84%, inclusive, the percentage is multiplied by 4, and the product is the number of weeks for which the claimant shall receive 66-2/3% of his average weekly earnings, not to exceed $38.00 a week or be less than $22.00 a week. If the disability is 85% or more, it is a permanent total case and claimant receives compensation for the remainder of his life. As an example of computing a permanent partial award, if the claimant receives an award of 20% disability, this figure is multiplied by 4, which is 80 weeks; if the claimant is entitled to the maximum weekly payments of $38.00, his total award would be that sum multiplied by 80 weeks, or $3040.00.

Under the 1961 law, if the employee dies from silicosis within six years from date of his last injurious exposure, benefits shall be the same as for other cases calling for death benefits.

4. Discussion of the relative advantages and disadvantages of the two statutes.

My discussion of the former and present West Virginia statutes will be confined to the manner of payment for permanent partial disability.

At first blush, it would appear that the revision made in 1961, whereby compensation for partial disability resulting from silicosis is to be determined in the same manner as in other cases of compensable injury, was eminently fair, but various considerations lead me to the opinion that the former statute is the better.

There are several differences between traumatic injury and the occupational disease of silicosis. In most cases of traumatic injury, the disabling event happens suddenly and the consequent disability is the result of one specific event; whereas, in the case of silicosis there is a continuing injury by exposure to silicon dioxide dust and this continuing exposure can be broken or terminated, and further resulting disability may thereby be arrested or minimized. Exposure to silicon dioxide apparently has a different effect on each person, whereas traumatic injuries usually have a similar effect on all persons. As to compensation, under both the former and present silicosis statutes, there is a difference between silicosis and traumatic injuries, as the sum that is paid to the silicosis claimant for the stage that is found is the only sum that is paid to him and no further benefits can be received for silicosis, except that there may be a death claim by dependents; whereas, in the case of traumatic injury, there may be further awards of greater benefits upon the timely showing of increased disability.

Thus, there being these three differences, perhaps more, between silicosis and traumatic injuries, it would appear reasonable that the method of payment for permanent partial disability should be different.

In view of the previous discussion, I believe that the fixed-sum method of payment for partial disability from silicosis is the best, for the following reasons:

1. The payment of a fixed sum encourages the workman to seek medical attention and diagnosis at the earliest sign of silicosis, whether it be shortness of breath, weakness, or other symptoms. If the workman knows that he may get a substantially larger sum if his pulmonary troubles are greater, he may well be inclined to postpone seeking medical attention. This may sound contrary to reason and good judgment, but many workmen are inclined to minimize their troubles and to want to avoid any break in their earning a livelihood.

2. Since the medical doctors have found the evaluation of partial disability from silicosis to be very difficult, as will be discussed later, I feel that they naturally will be inclined not only to be as liberal as they can to be sure to fully compensate the man, but also, knowing that the compensation is a "one shot" matter, they will be further inclined to look to possible later troubles and speculate on disabilities that may never occur. In other words, the medical evaluators will be inclined to substantially increase an award beyond the actual present disability. This is not a reflection on the medical profession, but rather an opinion of what may be done because doctors are conscientious and considerate in their appraisal. We have not yet had any adverse results in West Virginia because of exaggerated evaluation, since the enactment of the 1961 amendment, but this probably is due to our having an experienced and unusually able Silicosis Medical Board.

3. In any event, evaluation of a partial disability case of silicosis is very difficult. Since the 1961 statute was enacted, several doctors have asked me how they are going to go about evaluating a partial disability silicosis case, whereas I have never had any such inquiry as to any other type of compensation case. There is no statutory assistance in this respect, and undoubtedly there should not be any, and yet without some sort of guide and uniformity of criteria, uniformity of mechanical devices, uniformity in breathing capacity tests, and the like, there certainly cannot be any fair and uniform evaluation. In this situation, the over-evaluation mentioned earlier, will certainly result.

4. Then there is the problem that the compensation system perhaps cannot bear the financial impact of such a method of compensation for partial disability from silicosis. This has been the most practical and persistent obstacle to such compensation, and accounts for the present continuance generally of limitations on silicosis benefits. It is my understanding that when Wisconsin introduced full silicosis coverage, the insurance premiums for monument workers became higher than the payrolls, with the result that that industry was closed down in that state. (Larson's Workmen's Compensation Law, Section 41.20) This might appear to be a rather cold-blooded pecuniary approach, but it goes hand in hand with the proposition that a method that is both practical and economically sound may also be the one that more surely gets the men who are susceptible to silicosis away from working at a job where they may become worse and suffer total disability or death.

For these reasons, among others, it seems to me that the method of paying compensation for permanent partial disability resulting from silicosis, that prevailed in West Virginia prior to 1961 was the better statute, both from the viewpoint of the welfare of the workers and their future health, and from the practical financial aspect.

UNION'S VIEW ON PARTIAL COMPENSATION

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Pre 1961 Statute

Before getting into a discussion of the present West Virginia Silicosis Statute, it would probably be advisable to explain briefly the prior statute and the method of paying compensation for silicosis under the prior statute. In 1935 a statute was first enacted providing for compensation for the specific disease defined as silicosis. In this statute silicosis was divided into three stages, according to the disability produced thereby: First stage - - the earliest detectable signs of silicosis present without disability therefrom. Second stage - - the specific physical signs of silicosis present with capacity to work impaired by the disease. Third stage - - silicosis resulting in total permanent disability. The payment for the first two stages was changed from time to time, but in 1961, immediately prior to the enactment of the present statute, the payment was $1,000.00 for first stage, $2,000.00 for second stage and payments for life for third stage. In addition, of course, benefits were provided for the survivors of persons whose deaths were caused by silicosis.

The inadequacy of this statute is immediately apparent. The range of second stage disability could go from, theoretically, one percent through eighty-four percent. Yet regardless of the great difference between the physical condition of a man eighty percent disabled and one five percent disabled, both of these individuals were entitled to the same compensation, namely $2,000.00 for second stage.

Present Statute

For some years prior to 1961 various employee organizations including The United Mine Workers of America were agitating for a change in the silicosis provisions of the statute. Several different alternanatives were suggested and various bills were prepared and submitted to the legislature for consideration at various times. Bills providing for changes in the silicosis provisions were actually introduced in the legislature in the 1955, '57, '59 and '61 sessions. For thc last three of these sessions the bills were almost identical so far as compensation for silicosis was concerned. Finally, at the session in 1961, a bill was passed encompassing the present statute.

Under the present West Virginia statute silicosis is divided into only two stages - - first stage and advanced stage. First stage is as before - - silicosis without disability, and the amount paid is the same, that is, $1,000.00. In advanced stage silicosis a determination is made by the director of the extent of the claimant's disability from silicosis, and he is compensated in the same manner as for injury, that is, on a percentage basis. Under the West Virginia Compensation Statute permanent partial is disability of from one percent through eighty-four percent, while permanent total disability is eighty-five percent and above. For partial disability the claimant receives four weeks of compensation, at whatever his weekly rate may be, for each percent of disability. That is, ten percent pays for forty weeks, twenty percent for eighty weeks, etc. Permanent total disability carries weekly payments continuing for the life of the injured employee. The silicosis statute also provides that in no event is a claimant to receive less than the amount for first stage; that is, a man with five percent disability whose payments for twenty weeks would be less than the amount for first stage would nevertheless receive the minimum of $1,000.00.

The actual determination of the extent of disability is made, of course, for the director by the Silicosis Medical Board. I shall not attempt to explain to you the manner in which this determination is made since Dr. Stewart will cover that aspect of the problem.

Objections to Present Statute Made Before Passage

When the present statute was introduced as a bill in the legislature on the several occasions I have mentioned, the objections were numerous and vociferous. The first of these was what we might call the economic objection. It was claimed that this method of compensation would constitute a wholesale raid upon the Workmen's Compensation Fund and would "break" the Fund. It was realized by opponents of the change that this was a telling objection, since the legislators to whom these objections were made must be elected by people who work and own businesses.

The other main objection which was made was what we might call the medical or mechanical objection; that is, that it was not possible to measure the extent of the claimant's injury resulting from silicosis. The answers to this objection were many. First, there were numerous specialists in the field who felt that with pulmonary function studies and similar examinations medical science had progressed to the point that it could make the required determination. I must admit, however, that this was not a universal opinion among medical men. There was still a hard core of physicians who claimed that there was no satisfactory method of measurement. However, we could point out that in some states compensation was already being paid to claimants for partial disability due to silicosis based upon percentage of disability. In my own experience, beginning in 1949, I had handled hundreds of silicosis cases in the state of Virginia where compensation was paid on exactly that basis.

We could also point out that under the West Virginia Occupational Disease Statute a claimant was entitled to compensation on a percentage of disability basis for any other occupational disease, which might include any lung condition other than silicosis.

At any rate, the statute was enacted and we have lived with it in West Virginia since 1961.

Experience With Present Statute

As I have told you I am not now connected with any labor organization and in my practice I do not at this time handle many silicosis cases. However, in preparation for this meeting I have reviewed the records of District 29 of The United Mine Workers of America and have discussed this problem with them to bring myself up to date.

These people tell me that of the several hundred advanced stage silicosis cases they have processed in the last 3 1/2 years, the smallest disability they have had is fifteen percent. They have found no increase in the amount of permanent total disability from the old third stage disability. This is not to say that application of this statute does not present problems. However, these are essentially the same problems which existed before the present statute and they have not been increased or accentuated by the 1961 change, and here again we come to economics.

Under the union contract no employer is required to accept for new employment any applicant who does not meet the employer's physical standards. For many years all the major employers in the coal industry in southern West Virginia have required pre-employment X-ray films and have universally made a practice of refusing employment to persons who have any detectable signs of silicosis by X-ray, even first stage. This was true before 1961 and it is true today.

Even more of a problem is the plight of the man who had second stage of silicosis under the old statute and advanced stage with partial disability under the new one. Under the union contract if a man is laid off for economic reasons or for any other cause and is called back to work his employer may refuse to re-employ him if he has any disability at all. Once more this is true because the union contract contemplates the employment of healthy individuals who can deliver a day's work for a day's pay. The problem here is that a man with rather slight disability may be refused re-employment at the option of the employer. In the case of re-employment of a man already on the payroll the employer may not refuse to re-employ a man with first stage silicosis but he may refuse a man with any degree of advanced silicosis.

When the present statute was proposed one of the arguments against it was that an employer would not refuse to re-employ a man with second stage silicosis because as long as he did not go into third stage the employer could be liable only for a charge based upon second stage; while with the present law, it was argued, an employer would not re-employ a man with say fifteen percent disability because continued exposure to the hazard of silicon dioxide dust would almost certainly increase his disability and make the employer liable for a larger premium. However, as we pointed out at that time, the employer has a ready means of protecting himself. He can see that the man files his claim and collects for his disability before re-employing him as the statute provides that an individual may be compensated for silicosis only once in his lifetime. Likewise if he has been paid for less than total disability during his lifetime his survivors have no claim if he dies from silicosis.

This may sound like a rather hard-boiled solution to the problem, but this is a grave and serious problem, even more serious for the man who has contracted silicosis than for us who must concern ourselves with compensating him for it.

It is an easy thing to tell a man that he must leave mining for the sake of his health, that he will be better off in doing so, and that he is fortunate his employer will not re-employ him where he is exposed to the hazard, but it is difficult to answer this man who at age 35, 40 or 45 has had his livelihood removed when he asks, "What am I going to do now to support my family?" I have talked to scores of such individuals and I can tell you that I have never found a satisfactory answer to give them.

I am reminded of a meeting I attended in another part of the country several years ago when a doctor from Wales told us that they had tried removing from the mines every individual who had the slightest suspicion of lung disease, only to find that the economic results were worse than the problems they had set out to cure.

Nearly five years ago the Supreme Court of Appeals of Virginia considered this problem of the effect of partial disability upon a claimant's employment status in the case of Pocahontas Fuel Company v. Agee, reported in 112 S.E. 2d 835, in which I represented the claimant. Although that case was remanded for further development the court set the guidelines for further cases and I might add that after retrial Mr. Agee was granted a permanent total disability, even though his lung disability was only partial. I am informed by my colleagues who now handle workmen's compensation cases in Virginia that claimants there are granted total disability if the disability to the claimant's lungs, even though partial, removes him from the labor market.

However, I can tell you that the labor unions in West Virginia do feel that the present statute is a great improvement over the old one. This is not to say that it is perfect, but at least it is a step in the right direction. We all know, of course, that the purpose of workmen's compensation in general is to compensate the victims who have suffered injury or death from industrial accidents and diseases; not just to compensate them but to compensate them adequately for what they have lost. With this goal in mind the present West Virginia law is a giant step in the right direction, and it is the sincere hope of all of us who represent injured people that one day they may receive the full benefits to which they are entitled.

THE MECHANICS OF BREATHING IN DISABILITY EVALUATION[1]

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In evaluating the mechanics of breathing in a person such as a coal worker, we view the lungs and chest as a pump, and proceed to determine how well the pump is functioning. But a pump is incapable of feeling short of breath, whereas in man, disturbances of the mechanics of breathing often lead to breathlessness through several possible processes: increased work of breathing, arterial oxygen saturation, or pulmonary hypertension and cardiac insufficiency. Here, we will be concerned with the first of these. The increased work of breathing causes increased oxygen consumption of the respiratory muscles, and perception of a sensation of increased effort exerted during breathing, and this sensation is called 'dyspnea.' Direct questioning may elicit the information that the person feels difficulty taking a deep breath in, or cannot fill or empty his lungs rapidly with ease. Examination of the chest, fluoroscopy, and simple tests such as attempting to blow out a match placed three inches in front of the mouth wide open may confirm the fact that the person either is unable to move much air in and out of the lungs, or is unable to move it rapidly out of his lungs.

To express a deficit of lung expansion or air velocity quantitatively, it is necessary to use a spirometer. We have the person breathe in as much air as he can, and then blow out rapidly into the spirometer, while recording the results on a strip of moving paper. The deficit is revealed as a vital capacity (volume or per cent) less than predicted, or as the amount of air expired in a given time (volume per unit time or per cent of vital capacity) being less than predicted.

The result of spirometric tests carried out on a representative sample of an entire population of retired soft coal miners from West Virginia (1) is shown in Table 1. The investigators found that 46% of the coal workers had pneumoconiosis by x-ray, 60% had symptoms of phlegm, 79% had grade 2 dyspnea, and that pulmonary function became impaired with increasing years the men had worked underground. The effect of duration of work seemed to be separate from the effects of age, smoking, or roentgenographic category of the pneumoconiosis.

On inspection of the data in this paper, one wonders how it is possible for so many miners to have such shortness of breath when their average values for vital capacity and forced expiratory volume are only slightly or moderately disturbed. This finding differs from that in patients with pulmonary fibrosis or idiopathic emphysema because these have a similar symptoms but worse spirometer tracings. To analyze this question further it is necessary to enumerate the mechanical structures of breathing and their properties, as these properties may be affected by disease, and more particularly as they may be changed by pneumoconiotic lung disease.

Table 2 lists the components, properties, and disturbances of function of the mechanical system required for breathing. The items starred are those which seem to be affected in pneumoconiosis. I say "seem to be" because there is a lack of information resulting from a lack of testing as described in the following paragraph.

1. This work has been supported in part by a research grant H4797 from the Public Health Service.
2. This work was carried out during the tenure of a Research Career Award of the Public Health Service.

Table 3 lists the methods which are suitable for studying mechanics of breathing. These tests are applicable to normal subjects or to patients such as those who have been coal workers. However, because no epidemiological survey study on coal workers has as yet been reported using the tests listed in columns B and C, it is impossible to make definite statements concerning the possible derangements of component parts of the system of mechanics of breathing in people who have been employed as soft coal workers. Considerable retrospective experience has accumulated as a result of testing ex-coal workers who complain of shortness of breath. The difficulty with using this type of data as evidence that coal mining causes mechanical derrangements is in sample selection, i.e. there is a likelihood of weighting the population selected in favor of those who not only were coal workers but who also may have had intercurrent pulmonary disease not necessarily related to their past occupation. An example of a retrospective study on soft coal miners with dyspnea is that of references 3 and 4. Some values on mechanics of breathing of these subjects are quoted in Table 4. These data seem to show that bronchitis is an important feature of the disease.

One cannot disregard clinical experience pointing to bronchitis, because there is experimental evidence to show that exposure of the lower airways to particulate matter inhaled in the inspired air stream causes bronchoconstriction (5), that the response is sustained during exposure to dust if the exposure is continued for several hours (6), that the response is exaggerated in those miners who already have some pre-existing obstruction to airflow (7), and that the effect is not detected by measuring forced vital capacity but is measurable when using a body plethysmograph to record airway resistance (8). The effect appears to be reflex in nature, since in animals it is abolished by vagotomy (9).

At present, we do not know whether sustained or repeated exposure to inert (coal dust) particles results in a persistent change in airway resistance or in a change in microscopic appearance of the bronchial epithelium. The evidence gathered on cigarette smokers points toward the smoke particles as a cause of bronchoconstriction (10), and toward inhalation of cigarette smoke as a cause of proliferation of of the bronchial epithelial cells (11). However, corresponding studies are not available to tell us whether or not similar chronic changes in bronchial epithelium results from the inhalation of soft coal particles.

The symptoms recorded in references 1 and 3 are compatible with those of chronic bronchitis, and therefore one would suspect that soft coal particles do produce changes in the bronchial tree. Therefore, I would suggest that these changes be looked for, using the research physiological methods available such as airway resistance and pathological methods such as those used by Auerbach. These studies should be carried out on samples of mining and control populations selected according to epidemiological criteria such as those used in reference 1.

The question arises as to whether any special tests of mechanics of breathing other than spirometry should be used in evaluation of disability in individual coal workers. Without knowing what these special tests would reveal in an epidemiologically selected sample population of miners, it is not absolutely certain whether the tests would be specifically useful in evaluating individual miners who complain of dyspnea. Nevertheless, in our laboratory we do employ tests of lung compliance and airway resistance on all compensation cases because the results of these tests are independent of patient effort, and therefore tell us whether there is objective evidence of pulmonary tissue or airway change. The abnormalities to be expected may be deduced from Table 4. Vital capacity and forced vital capacity depend on maximal effort exerted by the person being examined, and the results, if low, are open to question. We find that most patients do try their best, but occasionally a patient will not deliver as much air as he should be able to during spirometric determinations either because he did not understand the instructions or because he did not wish to cooperate. Other objective test in which the results do not depend on patient effort are the nitrogen meter single breath test for uneven distribution of inspired gas, the single breath carbon monoxide diffusing capacity, and the arterial blood studies of oxygen tension, carbon dioxide tension, and pH. Taken together, these tests may cost about as much as a radiographic study of the gastro-intestinal tract (G. I. series), but the results provide objective data which may influence the future employability and earning power of the individual, and may affect the decision as to whether or not he is eligible for disability compensation. Therefore the expense of the tests may be small compared to the importance of the information gained.

Summary:

1. Mechanics of breathing is important in coal workers because it is possible that their shortness of breath may be attributable to increased work of breathing.

2. A survey of a representative sample of coal workers and a control group should be carried out to determine the specific derangement of the mechanics of breathing, and to determine whether they have increased airway resistance as part of chronic bronchitis. Pathological examination of the tracheobronchial tree at autopsy should be studied, as well.

3. Objective tests of mechanics of breathing should be added to the spirometric determinations now used in evaluating individual miners for disability compensation, because the spirometric tests depend on voluntary cooperation and maximal effort, whereas objective tests of mechanics of breathing do not.

REFERENCES

1. Hyatt, R. E., Kistin, A.D., and Mahan, T. K. Respiratory disease in southern West Virginia coal miners. Am. Rev. Resp. Dis. 89: 387-401, 1964.

2. "The Lung" by Comroe, J. H., Jr., Forster, R. E., II, DuBois, A.B., Briscoe, W. A., and Carlsen, E. Second Edition, Year Book Medical Publ., Chicago, 1962.

3. Stoeckle, J. D., Hardy, H. L., King, W. B., and Nemiah, J.C. Respiratory disease in U.S. soft-coal miners: clinical and etiological considerations. J. Chronic Dis. 15: 887-906, 1962.

4. Ferris, B. J. and Frank, N. R. Pulmonary function in coal miners. J. Occup. Med. 4:274, 1962.

5. DuBois, A.B., and Dautrebande, L. Acute effects of breathing inert dust particles and of carbachol aerosol on the mechanical characteristics of the lungs in man. Changes in response after inhaling sympathomimetic aerosols. J. Clin. Invest. 37: 1746-1755, 1958.

6. McDermott, M. Acute respiratory effects of the inhalation of coal-dust particles. J. Physiol. (London) 162: 53P, 1962.

7. Biebrecher, W., and Ulmer, W. T. Irritability of the bronchial system and exposure to dust. Med. Thorac. 20: 358-371, 1963.

8. Lloyd, T.C., Jr., and Wright, G. W. Evaluation of methods used in detecting changes of airway resistance in man. Am. Rev. Resp. Dis. 87: 529-537, 1963.

9. Widdicombe, J. G., Kent, D. C., and Nadel, J.A. Mechanisms of bronchoconstriction during inhalation of dust. J. Appl. Physiol. 17: 613-616, 1962.

10. Nadel, J. A. and Comroe, J. H., Jr. Acute effects of inhalation of cigarette smoke on airway conductance. J. Appl. PHysiol. 16:713-716, 1961.

11. Auerbach, O., Stout, A. P., Hammond, E. C., and Garfinkel, L. Changes in bronchial epithelium in relation to sex, age, residence, smoking, and pneumonia. New Eng. J. Med. 267: 111-118, 1962.

TABLE 1

CHANGES OF RESPIRATORY MECHANICS WITH X-RAY CATEGORY. FROM HYATT, et. al. (1).

X-ray Category	FEV_1 (li.)	MMEF (li./sec.)	VC (%)	RV/TLC (%)
0	3.46	3.24	96	37
1	3.49	3.13	94	35
2	3.33	3.12	96	37
3	2.97	2.59	87	36
P.M.F.	3.07	2.66	92	38

Footnotes

FEV_1 = Forced expiratory volume in one second.
MMEF = Maximal mid-expiratory flow rate.
VC = Vital capacity.
RV/TLC = Residual volume to total lung capacity ratio.
P.M.F. = Progressive massive fibrosis of the lungs.

TABLE 2

SCOPE OF MECHANICS OF BREATHING.
(starred items are affected in coal workers.)

The system:

Muscles, nerves.
Ribs, diaphragm, abdomen.
*Lung parenchyma.
*Conducting airways, upper airways.

Properties of the system:

Muscular force and innervation. Neural control.
Mechanical displacement.
*Amount of air contained or displaced.
*Rate at which air is displaced.

Alterations in the properties:

Neuro-muscular weakness.
Rigidity of the thoracic cage.
*Restricted expansion of the lungs.
*Upper and lower airway obstruction.
Increased surface tension in the lungs.
*Uneven rates of filling and emptying of different regions.
*Obliteration or compression of small blood vessels (i.e. lung capillaries).

TABLE 3

TESTS OF MECHANICAL FACTORS IN BREATHING (from "The Lung" (2)).

A. Office, Clinic or Small Hospital	B. Cardiopulmonary Laboratory in Medical Center	C. Research Cardio-pulmonary Laboratory
Maximal expiratory 8c inspiratory flow rates; spirogram; FEV; MVV (all tests performed before and after administration of bronchodilator drugs).	Pulmonary compliance. Total pulmonary resistance. Maximal inspiratory 8c expiratory pressures (oral 8c esophageal).	Airway resistance (body plethysmograph) Pulmonary tissue resistance. Compliance of thoracic cage.

Footnotes

FEV = Forced expiratory volume.
MVV = maximal voluntary ventilation.
Tests for lung volumes, for uneven distribution of ventilation, for uneven ventilation to bloodflow ratios, and for increased pulmonary vascular resistance are relevant to mechanics of breathing. Details concerning these tests may be found in the reference cited.

TABLE 4

SELECTED VALUES FOR MECHANICS OF BREATHING ON CERTAIN SOFT COAL MINERS WHO COMPLAINED DYSPNEA
(quoted by Stoeckle, et. al. (5) from Ferris and Frank (6)).

Degrees of Dyspnea	VC (L)	ERV (L)	RV (L)	CL (L/CMH_2O)	RL (CMH_2O/LPS)
Mild (2 Flights)	3.81	1.21	2.73	0.226	3.3
Moderate (1 Flight)	3.15	1.13	4.30	0.248	5.4
Severe (Walking on Level)	2.66	0.97	4.10	0.149	7.6

Footnotes

VC = vital capacity.
ERV = expiratory reserve volume.
RV = residual volume.
CL = lung compliance.
RL = pulmonary resistance.

INHOMOGENEITY WITHIN THE LUNG AND BLOOD GAS TRANSFER

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The object of the lungs can be considered to be two-fold. Firstly, the lungs have to oxygenate the blood. Failure to do this results in cyanosis or blueness of the skin. Secondly, the lungs have to perform their function without difficulty. Failure to do this results in dyspnea (shortness of breath). It is surprising at times how much these two functions or dysfunctions of the lung are separated: in some men with extreme dyspnea and disability, the blood is normally oxygenated and the skin is pink. Other men with less distress, and less apparent difficulty in breathing; may be deeply cyanosed. I point this out to emphasize that what I shall talk about today, namely failure in blood gas exchange, is only one aspect of the dysfunction of the lung. Nevertheless, it is a very important aspect of dysfunction. Moreover, studies in this field have the advantage that the disturbance in the arterial blood gases and the mechanisms which lead to their abnormality can be objectively assessed without the cooperation of the subject in making a maximum effort.

There are 4 main causes for failure to normally oxygenate the arterial blood. First, there may be an inadequate amount of oxygen in the inspired air as happens a) at a high altitude and b) at sea level when the gas being breathed contains less than 21% oxygen. This undoubtedly occurs in some mine accidents even in the absence of carbon monoxide poisoning. But it is an acute phenomenon and the blood gases should return to normal if the patient survives and comes back to breathe air. Second, there may be an inadequacy in the amount of total ventilation of the lung. This is important in some diseases such as poliomyelitis and obesity but so far as I know it is not a feature of the respiratory failure of coal miners. Third, there may be failure of oxygen to diffuse in solution through the alveolar wall which separates the alveolar gas from the capillary blood which it is supposed to oxygenate. This is attributed to an increase in the thickness of the alveolar wall, normally about 1 micron thick. This type of disability occurred in Beryllium workers in the past and in asbestosis. But so far as I know it is not a feature of the disability in coal miners. Fourth, we come to the question of distribution or the unevenness of distribution of the lungs. This is undoubtedly the commonest and most important cause of failure to oxygenate the blood. It is important because it is the cause of the cyanosis in that large and increasingly common group of diseases, collectively referred to as obstructive disease, including asthma, bronchitis and emphysema and I think, the pneumoconiosis of coal miners.

Uneven Ventilation of the Lung: For many years the lungs were regarded as a homogeneous organ, function being the same in all the different parts of the lung. Insofar as inhomogeneity occurred, it was regarded merely as a nuisance which made it more difficult to make accurate measurements on a supposedly homogeneous lung. In recent years, however, this inhomogeneity within the lung has been raised above the level of a nuisance to the investigator trying to make measurements, and has been elevated to the status of a subject of intense interest and importance. Thus a great deal of work has been done on the inhomogeneity of the lungs since World War II. Most of the work has been directed towards the inhomogeneity in obstructive disease of the lung.

Several methods have been used to measure the degree of uneven ventilation of the lung in health and disease. The first of the modern methods was that of Cournand et. al (Journal of Clinical Investigation, Volume 20, pages 681-689, 1941, and Journal of Clinical Investigation, Volume 23, pages 55-67, 1944). This method depended upon the patient breathing pure oxygen for 7 minutes during which time the nitrogen concentration in the lung normally falls from its initial air-breathing concentration of 80% down to a concentration of less than 2 1/2%. The concentration of oxygen in the lungs is measured by a forced expiration at the end of 7 minutes of oxygen breathing. In men with abnormal degrees of uneven ventilation of the lung the nitrogen concentration in this forced expiration exceeds 2 1/2% and in severe obstructive disease may be as high as 10%. This method involves 7 minutes of pure oxygen breathing and gas analysis either by the classical chemical Van Slyke method, or by the more modern physical nitrogen meter method.

A second group of methods depends on the rate at which the subject mixes helium gas from a spirometer in which it is initially present at a concentration of about 10%. After 3 or 5 minutes of rebreathing by normal subjects the helium concentration in the spirometer stops falling because rebreathing has mixed the helium between the spirometer and the lungs until it has the same concentration in both. (An important corollary of this method is the insolubility of helium in blood so that it only mixes into the gas in the lungs and not to any appreciable extent into the blood and body tissues in which a more soluble gas would dissolve.) In disease the poorly ventilated parts of the lung are so poorly ventilated that it takes a long time to mix the helium from the spirometer into these gas spaces. Hence the helium concentration in the spirometer continues to fall slowly for a long time, maybe for 15 minutes (Briscoe: Clinical Science, Volume 11, pages 45-58, 1952, and Bates and Christie: Clinical Science, Volume 9, page 17, 1950.) Use of this method requires a complex spirometer circuit, at least 15 minutes of the subject's time and a thermal conductivity meter to analyze for helium.

The third method is the simplest and the quickest method for assessing the uneven ventilation of the lung in an empirical manner. The subject takes a single breath of oxygen and then expires past the sampling needle of a nitrogen meter. In normal subjects the single breath of inspired oxygen mixed equally into all the alveoli of the lung, whether they emptied early or late in the succeeding expiration. Thus, no matter how far the subject breaths out there is little change in the alveolar nitrogen concentration, indeed this normally changes by less than 2% for every 500 cubic centimeters of additional expiration. In disease however, the alveoli which empty first in the succeeding expiration are the well ventilated alveoli which inspired much pure oxygen at the preceding inspiration; the alveoli which empty last are the poorly ventilated alveoli which took in little oxygen at the preceding inspiration. Thus as the diseased subject expires he successively empties alveoli which were less well ventilated at the preceding inspiration. Hence the nitrogen concentration rises as he continues to expire. This is quickly and dramatically shown in the graphic record of the rapidly analyzing nitrogen meter sampling from the mouth during the expiration. This is the quickest and simplest test of uneven ventilation of the lung (Fowler: Journal of Applied Physiology, Volume 2, pages 283-299, 1949, and Fowler: Physiological Review, Volume 42, pages 1-20, 1952).

Finally there is a method which is, while not a quick and easy method of testing numerous patients, is one which gives most information or most understanding about the uneven ventilation of the lung. This is the method of prolonged nitrogen washout (Briscoe, et.al.: Journal of Applied Physiology, Volume 15, page 785, 1960, and Emmanuel, et. al.: Journal of Clinical Investigation, Volume 40, page 329, 1961). In this method the subject breathes oxygen for 15 to 25 minutes and the amount of nitrogen washed out of the lung, i.e., the number of cubic centimeters of nitrogen eliminated from the lungs in each successive 1/2 minute is measured. Allowance is made for the amount of nitrogen coming out of the tissues. In normal subjects the nitrogen initially present in the lungs is washed out quickly in 3 to 5 minutes. In diseased subjects the nitrogen initially present in the lungs is washed out quickly from the well ventilated lung spaces so that the quantities eliminated in successive 1/2 minute periods of oxygen breathing decrease rapidly for the first few minutes as they do in normal subjects. Thereafter there is a striking difference from normal subjects. After the well ventilated lung spaces have washed out their nitrogen so that they now contain, for practical purposes, pure oxygen, the poorly ventilated parts of the lung continue to wash out nitrogen very very slowly so that after 25 minutes measureable amounts of nitrogen are still being eliminated from these lung spaces. When the data are plotted on semilogarithmic paper it can be seen, in most cases, that the later points lie on a straight line. This means that the poorly ventilated lung spaces are, for all practical purposes, behaving as one unit in which all lung spaces have the same ventilation per unit volume. It was because of this apparent homogeneity in this group of alveoli or lung spaces that Hickam et. al. (Journal of Clinical Investigation, Volume 33, page 1277, 1954) coined the phase "the slow space" to describe this important functional unit.

The Mechanism Causing Arterial Oxygen Unsaturation: It is the ventilation of the slow space which largely determines the failure to oxygenate the blood in patients with obstructive disease. This can be realized when we consider the following typical figures. The slow space which occupies 3 liters, i.e., 3/4 of the volume of the lung, and is ventilated by only 1/2 liter per minute of fresh air, i.e., 1/10 of the alveolar ventilation has to oxygenate about 2.5 liters of venous blood per minute, i.e., 1/2 of the venous blood which comes to the lungs to be oxygenated. With a ventilation perfusion ratio of only 0.2 in the slow space the blood oxygenated here is only 76% saturated with oxygen.

On the other hand the fast spaces in this typical example occupy about 1 liter, i.e., 1/4 of the lung volume is ventilated by 4.5 liters of fresh air per minute, i.e., 9/10 of the alveolar ventilation and perfused by 2.5 liters of venous blood per minute, i.e., about 1/2 the cardiac output. With a ventilation perfusion ratio of 1.8 the blood oxygenated in the fast spaces is 98% saturated with oxygen. When the well oxygenated blood from the fast spaces is mixed with the poorly oxygenated blood from the slow spaces the resulting mixture in the arterial blood is 87% saturated with oxygen. Normally it is about 95%.

This mechanism is presumably that by which coal miners develop anterial oxygen unsaturation. However, most of the detailed analysis of this particular type of disturbance in ventilation perfusion ratios in recent years has been carried out in a few university centers in large cities such as New York, Boston, Buffalo, San Francisco, where the major cause of respiratory insufficiency is bronchitis and emphysema, and where comparatively few, if any, coal miners disabled by respiratory insufficiency are seen. It may be because these particular academic centers are geographically separated from the major coal fields that comparatively little has been published recently on the disability of coal miners using recent highly sophisticated physiological techniques and methods of interpretation.

Methods Which Might be Used in Miners to Measure Inhomogeneity Within the Lung: Inhomogeneity affects several aspects of function - ventilation, perfusion and ventilation perfusion ratios may be inhomogenous in different ways. The most easily measured inhomogeneity is that in ventilation and we have already outlined and described 4 methods for doing this. The quickest and simplest of these for screening large numbers of subjects is Fowler's single breath method. The method which gives most information is the prolonged nitrogen washout.

There is another method of great interest which has not been mentioned yet because it assesses inhomogeneity not of ventilation but of ventilation perfusion ratios. This is the measurement of urinary dissolved nitrogen. The nitrogen in the body behaves as an inert gas and is believed not to enter into the metabolism of any organ. Its partial pressure in blood and urine should at first sight be the same as that in the ambient air. However, in alveoli with a low ventilation perfusion ratio and respiratory quotient the partial pressure of N_2 exceeds that of ambient air. In alveoli with a high respiratory quotient the partial pressure of N_2 is less than in ambient air. This leads, in fact, to the partial pressure of dissolved N_2 both in blood and in urine being above that in ambient air. In normal men the urinary N_2 pressure exceeds that mixed alveolar air by about 5 mm Hg. In men with severe disturbances in V/Q ratios the difference is greater, i.e., up to about 30 mm Hg. This is the only pulmonary function test which can be performed on a urine sample and it may conceivably be of interest in miners. (Rahn and Klocke: Journal of Clinical Investigation, Volume 40, page 286, 1961, Briscoe and Gurtner: Federation Proceedings, Volume 19, page 381, 1960)

Another method which can be used to assess the end results of the inhomogeneity is the analysis of the arterial blood for oxygen and carbon dioxide. This necessitates an intra-arterial needle, a routine procedure in cardiopulmonary laboratories in hospitals. It may not be suitable for screening large numbers of men however.

It may be worth noting that none of these tests for inhomogeneity can be deliberately influenced by the subject. This is in contrast to some other tests such as the maximum breathing capacity or vital capacity where one sometimes wonders whether an abnormal result was due to a lack of effort on the part of the patient.

Interpretation of Abnormal Findings: Having outlined several methods for determining the degree of inhomogeneity in the lung, the question arises as to how an abnormal result should be interpreted. An abnormal result only shows that the patient has a physiological disturbance which is often seen in disabled people. It does not indicate whether the patient is disabled by emphysema, by bronchitis, by asthma or by pneumoconiosis. In coal mining districts where many men with respiratory insufficiency have been coal miners the disability is naturally attributed to the coal dust. In Bellevue Hospital we see many men who are terribly disabled by respiratory insufficiency and who eventually die of it. The cause is bronchitis

and/or emphysema. Since practically all these sufferers in New York have been, and indeed usually still are, heavy smokers, some physicians attribute this type of respiratory insufficiency to smoking. Indeed in the few men with pneumoconiosis who I remember seeing in New York it is difficult to decide how much of their disability is due to pneumoconiosis and how much is due to emphysema.

Other Aspects of Lung Function: Although these remarks are mainly concerned with blood gas transfer it is worth pointing out that failure to saturate the arterial blood with oxygen does not usually develop till ventilatory insufficiency is far advanced. In screening large numbers of people to detect and, if possible, prevent the downward progression of individuals in an early stage, much simpler tests seem to this speaker, to have most value. These tests are the simple tests of bellows function, i.e., timed vital capacity and maximum breathing capacity. Admittedly an occasional normal individual may, through lack of understanding what is required, give an abnormal result. But every individual who gives an abnormal result deserves further attention, investigation and advice.

EXERCISE STUDIES IN DISABILITY EVALUATION

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Exercise studies are of great aid in determining disability in patients with cardiopulmonary disease. Exercise provides an actual test of over-all functional ability, simulating actual work performance. Thus a simple determination of the maximum exercise capacity provides one measure of fitness. The mere loss of exercise capacity, however, does not imply definite impairment of cardiopulmonary functional capacity. Loss of exercise capacity can occur in perfectly normal individuals from prolonged inactivity. Recent acute illness, impairment of function of other organ systems, such as renal disease, anemia and so forth, must be considered when exercise studies are interpreted. It is also true that the ability to perform at a given work load does not necessarily imply that an individual is functionally able to perform at a steady rate at this level. It is essential to measure a number of physiologic responses to exercise in order to make a more reasonable estimate of work capacity.

One of the major objectives in disability evaluation or in rehabilitation is the estimation of an optimal level of work for a given individual. In normal men it has been stated that the maximal steady working rate should not exceed that level of work requiring 50% of the maximal possible oxygen consumption. In individuals with cardiopulmonary dysfunction, it has not been demonstrated that this same relative level is ideal. Much more work is necessary before any relationship between oxygen consumption and work capacity in cardiopulmonary patients can be established.

Even in normal subjects it is difficult, time consuming, and sometimes impossible to achieve an exercise level sufficient for maximum oxygen uptake. For this reason, estimates have been made by extrapolating various physiologic responses, such as heart rate, at submaximal work levels. These observations, while not entirely accurate, do provide adequate estimates in normals. Such studies are helpful in patients with cardiopulmonary disease, although in some cases there are significant discrepancies in heart rate/oxygen uptake. Simultaneous measurement of heart rate, oxygen uptake and minute ventilation often provides very useful information in estimating functional ability.

We are attempting to evaluate the significance and reliability of submaximal exercise responses in disability determination among coal miners. All patients are given an exercise test with measurement of heart rate, respiratory rate, minute ventilation, and oxygen consumption at various levels of work on a bicycle ergometer. Currently we use graduated levels of 25, 50 and 75 watts for 5 minutes each, with no pause between levels. This level is sufficient to approximately triple the oxygen requirement above the resting requirement. Normal subjects are capable, with greater work loads, of increasing O_2 uptake 10 or more times above the basal requirement.

Measurements are made during the final 60 seconds of each work level and at intervals during a 10 minute recovery period. ECG is continuously monitored oscillographically and recorded as desired. Recovery measurements are made at the end of the highest work level attained, since all patients are not able to complete the test. Following a rest period, repeat exercise levels are given, with measurement of blood gases and analysis of expired air. Patients are required to perform at the maximal possible load, or up to 120 watts, which is only a moderate exercise level. Each level is maintained, if possible, up to 20 minutes with blood gases analysed at 3 to 5 minute intervals after the first 5 minutes of exercise.

It is possible for some patients to increase their exercise capacity to double the initial maximal, even in the space of a single day's observation. Unfortunately, for the most part, it has been necessary for us to complete all our studies during a single day. Ideally, as others have shown, a period of several days practice would enable subjects to improve work performance and would allow patients to become familiar with laboratory procedures and equipment.

Many of our cases have limited their physical activity to a marked degree, often far out of proportion to any degree of physiologic impairment. Some of these have been unable to exercise to a level sufficient for any reasonable estimate of true functional loss. We are now hopeful that we may keep our patients for 3 or 4 days of exercise before our final studies are completed. This will enable us also to determine the possible effect on responses to the standard test during this short training period. It is well known that long term physical training in normals can alter at least some of these responses.

Our experience to date indicates that, provided adequate measurements of several parameters are carried out simultaneously, reasonable estimates of functional impairment can be made from a submaximal exercise study. It is important to stress, however, that reliance on heart rate and oxygen consumption only, or on minute ventilation and oxygen consumption alone, may be misleading . For example, in case No. 3 below, the patient had a heart rate of 56 at rest. With exercise levels of 25 - 75 watts his rate increased only to 88. His oxygen consumption increased as expected, at least to this level of light work. Extrapolating these results gives a predicted maximal oxygen uptake of 3.38 L/min. Simultaneous blood gas analyses, however, showed progressive desaturation between 50 and 75 watts. It is, therefore, unrealistic to assume this man could have achieved an oxygen consumption of 3.38 L/min. The ratio of oxygen consumption/minute ventilation, however, revealed a markedly reduced value of 1.92%, compared to an expected value of 3.5 - 4%.

Exercise studies performed in cases 1 and 2 clearly indicated significant impairment of functional capacity. Despite normal values of vital capacity, normal air flow, lung volumes, airway resistance and single breath Nitrogen washouts, exercise measurements revealed reduced predicted maximal oxygen uptake and oxygen removal. These two cases also point out the necessity of performing more than the simple ventilatory measurements in disability evaluation, even though the ventilatory studies are normal.

Case number 4 similarly demonstrates the value of exercise studies. Although he maintained normal oxygen saturation to the 75 watt level, he essentially achieved his maximal possible oxygen consumption at this light exercise level. His vectorcardiogram revealed significant right ventricular hypertrophy.

In conculsion, exercise studies, when performed at known work levels, with accurate measurements of heart rate, respiratory frequency, minute ventilation, and oxygen consumption, can aid in determining disability in patients with cardiopulmonary diseases.

The case histories of several patients in whom exercise studies were of considerable aid in evaluation follow.

Case No. 1: R. W. A 57 year old Negro handloader and loading machine helper who spent 32 years in his underground occupation. He smoked 1 pack of cigarettes per day since childhood. He complained of external dyspnea, moderate morning cough and scant sputum production. Chest X-ray showed Category B complicated pneumoconiosis with a Category III-p background. Heart size was normal. ECG, CBC, urinolysis normal.

	PREDICTED	OBSERVED
FEV total (L)	4.46	3.85
FEV_1 (L)		3.22 (84%)
FEV_3 (L)		3.77
FEF 25-57 (L/sec)	4.15	3.56
FEF 50-75		2.97
MVV_f (L/min)	157	62
N_2 Single Breath (%)	1.8	2.8
RV (L)	2.77	3.18
TLC (L)	7.23	7.43
RV/TLC (%)	38	43
Resistance (cm/L/sec)	.71	.62

From Ergometrics:

Maximal predicted oxygen consumption	2.07 L/min
	26.6 cc/kg/min
Maximal aerobic work capacity	77 watts
Oxygen uptake/minute vent	1.85

Blood Gas and Expired Gas Analysis:

	PREDICTED	REST	EXERCISE 50 Watts 5 min	8 min
Heart Rate		63	126	
Minute Volume	7.8	13.9	72.3	
Tidal Volume		695	2259	
Fct Dead Space		370	1009	
VD/VT	35	53	45	
Alv. Vent	5.1	6.5	40.0	
% Total	60-70	47	55	
Fct Dead Space Vent	2.7	7.4	32.3	
DS/Alv. Vent %	54	114	81	
O_2 Uptake (cc/min STPD)		328	1338	
CO_2 Output (cc/min STPD)		318	1621	
R		.97	1.21	
Min Vol/O_2 Uptake		42	54	
Alv. O_2 Min Hg	91	94.5	104.3	
Alv. - Avt O_2 Gradient		28.2	68.6	
pH	7.38-41	7.435	7.465	7.435
pO_2	75-95	66	36	33
pCO_2	40	42.5	35	
pCO_2 % Sat.	93-97	92.6	76	65.6

Case No. 2: A 42 year old Caucasian coal miner. He quit working because he claimed to be too dyspneic to continue. He gave a history of moderate cigarette smoking, minimal cough and sputum production. Examination was not remarkable except for tubular breath sounds over the chest. X-ray revealed category II-r simple pneumoconiosis. ECG was not remarkable.

	PREDICTED	OBSERVED
FEV total (L)	3.60	4.25
FEV_1 sec (L)	3.19	3.90 (92%)
FEV_2 sec (L)		4.25 (100%)
FEF 25-75 (L/sec)	3.35	6.55
FEF 50-75 (L/sec)		3.86
N_2 Single Breath (%)	1.8	3.4
TLC (L)	4.39	6.64
RV (L)	.79	2.48
RV/TLC (%)	18	37
Resistance (cm/L/sec)	.89	.10

From Ergometrics:

Predicted Maximal Oxygen Consumption ..... 1.54 L/min
29 cc/kg/min

Oxygen Removal Rate 2.91

Blood Gas and Ventilatory Studies:

	PREDICTED	REST	EXERCISE 60 Watts 5 min	10 min	Oxygen
Heart Rate		64	144		
Resp. Frequency		24	54		
Minute Volume (L/min)	4.8	12.8	38.2		
Tidal Vol (cc)		533	707		
Phys. Dead Space		130	204		
VD/VT (%)	35	24	29		
Oxygen Uptake (cc/min)		209	1110		
Carbon Dioxide Output		238	1022		
R		1.14	.92		
Min Vol/oxygen Uptake	25-31	61	34		
Alv. Oxygen (mm/hg)	91	95	108		
A-A Gradient	13	0	37		
pH	7.38-41	7.495	7.440	7.420	7.360
pO_2	75-90	95	71	58	630
pCO_2	40	35	37	40	37
% Sat.	93-97	97.2	94.6	89.1	

Case No. 3: E. M. Age 54 Ht. 179cm, Wt. 69 kg, BSA 1.88. A working coal miner who complained of dyspnea for 3 to 4 years, cough and sputum production for 7 to 8 years. He noted wheezing with chest colds. He smoked 1 pack per day for 35 years. He had worked all his adult life in the mines. X-ray revealed simple pneumoconiosis and normal cardiac shadow. ECG was suggestive of RVH and this was definitely confirmed by vectorcardiogram.

	PREDICTED	OBSERVED
Fev total (L)	4.33	1.73
FEV_1 sec (L)	3.03	1.30
$FEV_{2.5}$ sec		1.73
FEF 25-75 (L/sec)	4.03	1.32
FEF 50-75 (L/sec)		.96
MVV_f (L/min)	153	31
N_2 Single Breath (%)	2.0	3.2
TLC (L)		7.18
RV (L)		5.43
RV/TLC (%)		75
Resistance (cm/L/min)		.68

From Ergometrics:

Predicted Maximal Oxygen Uptake . . . . . 3.38 L/min
48.2 cc/kg/min
Oxygen Removal Rate 1.92

Blood Gas and Ventilatory Studies:

	PREDICTED	REST	EXERCISE		
			50 Watts 5½ min.	75 Watts 6 min.	Rest 100% Oxygen
Heart Rate		56	80	88	
Resp. Frequency		32	46		
Minute Vol.	7.3	15.2	47.9		
Tidal Vol.		475	1014		
Fct. Dead space		244	426		
VD/VT	35	51	41		
Alv. Vent.	4.7	7.4	28.3		
% Total	60-70	49	59		
D. S. Vent	2.6	7.8	19.6		
DS/Alv. Vent %	54	105	69		
O_2 Uptake		274	920		
CO_2 Output		346	1196		
R	.82	1.26	1.30		
Min. Vol/O_2 upt.	25-31	55	52		
Alv. O_2 (mm/Hg)	91	100.9	105.8		
A-a Gradient (O_2)	13	28.9	45		
pH	7.38-41	7.530	7.475	7.450	7.520
pO_2	75-90	71	61	52	525
pCO_2	40	40.5	36.5	36.5	40.5
% O_2 Sat.	93-97	95.1	91.3	86.5	

Case No. 4: L. B. Age 41 Ht. 177 cm Wt. 68 kg BSA 1.84. This man worked 22 years in the coal mines. He quit work because of exertional dyspnea and chest pain. He smoked 1-1½ packs of cigarettes daily and had done so since childhood. He had cough and sputum production with respiratory infections only. Physical examination was not remarkable. Chest X-ray revealed Category I simple pneumoconiosis, and normal heart size. ECG showed right axis deviation. His vectorcardiogram indicated significant right ventricular hypertrophy.

Spirometric studies were entirely within the normal range as were his lung volumes and airway resistance measured in the body plethysmograph.

From Ergometrics:

Predicted Maximal Oxygen Uptake . . . . . 1.49 L/min
21.0 cc/kg/min

Oxygen Removal Rate 1.84%

Blood Gas and Ventilatory Studies:

	PREDICTED	REST	EXERCISE		
			75 Watts 5 min.	Rest 15.7% Oxygen	Rest 100% Oxygen
Heart Rate		108	180	108	
Resp. Frequency		18	38	20	
Min. Vol.	7.2	11.7	79.7	12.2	
Tidal Vol.		650	2097	610	
Fct. Dead Space		278	832	245	
VD/VT	35	43	40	40	
Alv. Vent.	4.7	6.7	47.9	7.3	
% Total	60-70	57	60	60	
D. S. Vent.	2.7	5.0	31.6	4.9	
D. S/Alv Vent.	54	75	66	67	
O_2 Uptake		338	1470	336	
CO_2 Output		257	1609	237	
R	.82	.76	1.10	.71	
Min. Vol/O_2 Uptake	25-31	35	54	36	
Alv. O_2 (mm/Hg)	91	96.8	106.6	66.0	
A-a O_2 Gradient	13	32	18	25	
pH	7.38-41	7.530	7.490	7.520	7.490
pO_2	75-90	65	88	41	550
pCO_2	40	33	29	28	30
% O_2 Sat.	93-97	94.2	96.7	80.3	

COMMONWEALTH'S DUST EVALUATION ACTIVITIES IN COAL MINES

DUST SAMPLING AND ANALYSIS

Paul Biskup, Chief Mine Foreman
Department of Mines and Mineral Industries, Ebensburg

Arrangements are made through the Ebensburg Office with mine management and the district mine inspector to have the dust survey made.

The dust inspectors are met at the mine by the district mine inspector who acquaints them with local mine management. At this meeting the dust inspectors are given an orientation pertinent to the operation of the mine. Included in this are the number and type of operations, name and number of air splits and the quantity of air ventilating each.

Plans are then completed to start the survey and, if suitable space is available, a laboratory is set up on company property for convenience sake.

Dust samples are collected by the use of a midget impinger. Although not a perfect instrument in itself, it will, when calibrated, give similar results under similar conditions.

Time weighted dust exposure samples are collected at the beginning of the shift and for 5 minutes at 15 minute intervals each quarter hour during the entire shift. While the perfect sample would be a continuous sample for the entire day, it is understood that with this method an average will be reached. Four 5-minute samples are integrated into each hourly impinger sample so that during an eight-hour day 8 samples will be collected.

These samples along with a dry dust sample collected on a settling sheet and other pertinent data as quantity of ventilation, control of ventilation, number of water sprays and other contributing factors in dust dispersement are noted.

Wet samples collected in an impinger using Isopropyl alcohol as collecting agent are then counted in a micro-projector within 24 hours of collection of sample.

The dry dust is brushed into a sample bottle and after labeling is sent to the Pennsylvania Department of Health for silica determination.

The micro-projector is an apparatus employing a microscope and mirror device which projects the image of dust on a screen at 1000 diameter magnification where, after necessary preparation or dilution, dust in sample is counted and mathematical computation is used to determine time weighted exposure of the workman or operator.

Complete reports on this are sent to the office of the Deputy Secretary of Mines and Mineral Industries where the data is evaluated and any recommendations necessary are then made.

COORDINATION OF DUST CONDITIONS FOUND IN BITUMINOUS COAL MINES

J. A. Blackburn, Deputy Secretary
Department of Mines and Mineral Industries, Ebensburg

Preliminary arrangements are made from the Ebensburg Office, through the Mine Inspector, for the Dust Investigators to meet mine management and to be oriented as to mine layout, ventilation, installation and requirements. The Mine Inspector is a party to the first day of orientation.

The method of face ventilation, quantity and method of conducting the air to the face, rock-dusting and use of water on the first series of tests, together with the result of the tests are discussed with the Dust Investigators at a meeting in the Ebensburg Office. If the first tests are unfavorable the Mine Inspector is notified and requested to visit the mine to recommend alterations in ventilation and water application so that a re-check of the area will show the dust problem reduced to an allowable limit. If subsequent areas are unfavorable they, too, are changed in ventilation and water control.

The final report is discussed with the Dust Investigators and all practices considered as sub-normal are listed and this list is sent to the Mine Inspector with a request that he contact management for correction.

Some ventilation problems are presented that are hard to overcome. In the highly gassy mines positive face ventilation is necessary to control the methane. This causes the dust to be carried over the workmen from the face region. Frequently we have difficulty with both men and management in the use of respirators, inactive water sprays or sprays that have become enlarged and are no longer effective as sprays.

The final report is submitted to the Department of Health and a representative of this Department checks and counter checks the report in the Ebensburg Office with the Dust Investigators and the Deputy Secretary of Mines and Mineral Industries.

The conditions noted, with corrections, are outlined to the Mine Inspector of the District, a report of which is sent to mine management and the central office of the Department of Mines and Mineral Industries in Harrisburg.

One mine was reinspected for dust conditions one year after the initial investigation. Conditions in this mine showed no great improvement.

Mining during the dry season has an adverse effect on dust elimination, especially in those mines that are not a great distance underground.

Two check investigations were made of mines of average dust count. The one mine employing mechanical mining had improved approximately 50% thru the activities and suggestions of the Department of Mines and Mineral Industries. The other mine was a hand loading mine where spray and water facilities were limited. No apparent improvement was noted in this mine. Hand loading, except for small, domestic mines, is practically finished. The number of older men subject to this ailment can attribute the cause to their early mining life.

THE ROLE OF THE MINE INSPECTOR IN DUST CONTROL IN BITUMINOUS COAL MINES

Thomas E. Jones, Bituminous Mine Inspector
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The Bituminous Coal Mining Laws of Pennsylvania place the responsibility of providing for the health and safety of employes in and about the Bituminous coal fields of Pennsylvania on the Department of Mines and Mineral Industries. The laws also require the mine inspector, the mine superintendent and the mine foreman to see to it that the laws are faithfully executed.

The allotted time does not permit a lengthy discussion of the many duties of mine officials relative to the health and safety of employes; however, I will mention several provisions of the laws as they pertain to dust and ventilation:

In all coal mines dangerous accumulations of fine dry coal dust shall be removed from the mine or neutralized by the application of rock dust on all dry and dusty operating sections, haulageways and back entries for at least one thousand feet away from the first active working place in each operating section shall be kept watered down or rock-dusted, or the dust allayed by such other methods as may be approved by the Department. Coal dust and other dust in suspension in unusual quantities shall be allayed by sprinkling or other dust allaying or collecting devices.

In all dry or dusty mines, or sections thereof, rock dust shall be applied and maintained upon the roof, floor and sides of all operating sections, haulageways and parallel entries connected thereto by open crosscuts. Back entries shall be rock-dusted for at least one thousand feet away from the junction with the first active working place. Rock dust shall be so applied to include the last open crosscut of rooms and entries, and to within forty feet of the face except in mines where mining is done by continuous-type mining machines, in which case the distance from the face the rock dust applied shall be the mining distance for each shift, providing, that the active working place is kept from damp to wet and, further provided, that after coal production on any shift has ceased an application of rock dust is made in the exposed area to within forty feet of the face before additional mining is performed in said area.

Rock dust shall not contain more than five per cent by volume of quartz or free silica particles and shall be pulverized so that one hundred per cent will pass through a twenty-mesh screen, and seventy per cent or more will pass through a two hundred-mesh screen.

The superintendent shall see that a representative sample of dust is gathered at each sampling point from the roof, sides and floor of all entries by a competent person, once each two months while the mine is in operation, and tested to determine if any part of the mine requires re-dusting.

Ventilation Requirements:

The operator or superintendent of every mine shall provide and maintain ample means of ventilation to furnish a constant and adequate supply of pure air for the employes. The quantity and velocity of the current of air shall be sufficient to dilute, so as to render harmless and carry away, flammable or harmful gases. The quantity of air reaching the last open crosscut in any set of entries shall not be less than six thousand cubic feet per minute. All active underground working places in the mine shall be ventilated by a current of air containing not less than 19.5 per cent of oxygen, and not more than 0.5 per cent of carbon dioxide and no harmful quantities of other poisonous gases.

The mine foreman shall notify the superintendent in writing whenever in his opinion the mine is becoming dangerous through the lack of ample ventilation at the face of entries, rooms and other portions of the mine, caused by the undue length of entries and airways or from any other cause resulting in the accumulation of gas or coal dust or both in various portions of the mine. The superintendent shall thoroughly investigate the mine foreman's report and, if substantiated, necessary work shall be done to put the area in a safe operating condition. It shall be the duty of the superintendent to immediately notify the Mine Inspector in the district of such condition. The Mine Inspector is required by law to use sound discretion in the performance of his duties and shall make a thorough investigation of all substandard conditions under his observation or received from any other source. When the Deputy Secretary of Mines and Mineral Industries notifies the Mine Inspector that a substandard condition or conditions were reported in the dust control survey report, he contacts mine management and directs them to eliminate the substandard condition as soon as possible. We have found management to be very cooperative.

Due to the time elapsing between dust control surveys, the District Mine Inspector checks the following to see that the mines are maintained in a healthful condition:

Ventilation – We recommend that a positive method of face ventilation be put into practice with the ventilation aiding in the control of dust in suspension. The ventilation shall be so controlled that the pressure side of the ventilating current be on the return of each working place, permitting the machine and the shuttle car operators to work on intake air.

Drilling Operations – All employes working in dusty locations are required to wear respirators. Stoper drills must be provided with hollow steel drill bits and vacuum dust collectors.

Transportation – (a) Locomotives shall be large enough to transport coal to the surface without using a large amount of sand.

(b) Haulage roads shall be kept clean and well drained.

Shuttle Car Runways – The adoption of rubber-tired shuttle cars underground, in conjunction with mobile coal loading machines, has introduced new problems in the control of dust on roadways where this type of loading and transportation is used. Development and extraction are generally rapid, with the result that much coal is spilled from the shuttle cars during normal operation. Coal in the roadways from this source and from sloughing of the ribs is ground to fine dust by the wheels of the shuttle cars and by the treads of the loading and mining machines. The coal dust usually is contaminated by pulverized rock and the mixture could not be loaded with the run-of-mine coal without undue contamination of the product even if it were cleaned up promptly.

The presence of large quantities of fine loose dust, which is constantly stirred up and kept in suspension in the air by traffic, constitutes a grave explosive hazard, reduces visibility along the runways and is harmful to the workmen who breathe the air. The dust explosion hazard is eliminated or reduced by frequent applications of sufficient rock dust on the road bed, but this does not remedy other difficulties - in fact it might intensify them. The most direct and effective means is to clean up and remove promptly all dust that forms and settles on the runways and apply water to prevent dispersal of the dust into the air and consolidate it on the mine floor.

Calcium chloride has been used to allay dust on mine roadways but the workmen complain that their clothing, especially their shoes, is attacked by the salt. Where animals were used for haulage, the hair and hoofs of the animals were attacked by the salt. These objections have not been raised against sodium chloride, in part possibly for the reason that this material has not been used as widely for allaying dust as calcium chloride. There is little doubt that both salts have a corrosive effect on leather and cloth, especially during the period when deliquescence is most active. A coating of either of the salts appears to draw moisture from the fibers of material and forms a gummy deposit on the surface. Both salts are active electrolytes in solution and promote corrosion of metal. The industry abandoned the use of calcium chloride because bare copper conductors were attacked and cable splices deteriorated rapidly. The application of salt does not reduce the explosive hazard of dust that clings to the surface of the roof, rib and timber and the need for rock-dusting these surfaces is not eliminated.

Continuous Mining Machines – Since the introduction of the boring-type mining machine, a serious dust and ventilation problem has been created. Several coal companies appreciated the gravity of this situation and requested the Secretary of Mines and Mineral Industries to grant permission to use small fans to assist in ventilating the immediate working face. Upon receiving this request, the Secretary of Mines and Mineral Industries appointed a Commission of Bituminous Mine Inspectors to make an investigation and report their findings. After receiving the Commission's report the Secretary granted the companies permission to use a small fan, providing the fan is equipped with hydraulic or enclosed electric-driven motors. All installations were to be approved by the Commission and the State Electrical Inspector. Some companies used a blower system, others an exhaust system and some used a combined exhaust and blower system. With the blower system, intake air at a high velocity can be directed against the face or the miner head. If air volume is adequate this high velocity is very effective and provides a good face sweep. The main disadvantage of blowing systems is the dust that goes into suspension and blows back beyond the machine and shuttle car operators. Visibility may be poor and harmful dust concentrations may exist.

With the exhaust system, the quantity of air available at the face may be sufficient, but unless the duct or tubing is maintained close to the face the velocity will be inadequate to sweep the air across the face. Certain face areas may not be ventilated and methane concentrations may develop; however, the dust problem at the face is greatly reduced by the exhaust system. Dust thrown into suspension is drawn into the duct and discharged into the return air course. Of course, this dust complicates the problem of rock-dusting and cleanup.

Combined Exhaust and Small Blower System – Using a small blower in conjunction with the exhaust system provides the advantage of both systems. The small blower or diffuser, either separate or mounted on the continuous miner, delivers air at high velocity to the face. The dust that is entrained with the air is drawn into the exhaust system. The principal disadvantage to this system is that both fans must be operating to be truly effective. If the exhaust system stops for any reason and, if by mistake, the equipment continues to work with the diffuser operating, the diffuser can by re-circulation, build up methane concentrations at the face that may be ignited by mining bits.

Recommendations – Governing the Installation and Operation of Water Sprays on Mining Machines and Belt Conveyors:

(1) The number of fog-type water sprays installed on mining machines and loading machines shall be adequate to prevent excessive amounts of coal dust from being thrown into suspension.

(2) Should any of the sprays become clogged or defective, operation of the machines shall be stopped until repairs have been made.

(3) Fog-type water sprays shall be installed at all belt loaders, dumping points, air-lock doors and other locations where an excessive amount of coal dust may be thrown into suspension. We have found that a healthy atmosphere is dependent upon an efficient combination of ventilation and water sprays. It is not the quantity of water but rather the manner of application that assures maximum dust control.

CO-ORDINATION OF DUST CONDITIONS FOUND IN ANTHRACITE MINES

Gordon E. Smith, Deputy Secretary
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Anthracite mines present some very obvious differences as compared to other types of mining, said differences are mainly resultant from the physieal conditions encountered. The pitches, which vary from flat to vertical, the multiplicity of seams with varying thicknesses and quality of intervening strata, together with the innate tendency of water to follow the coal seams downward, produce varying eondi-tions, even within the same coal seam in the same general area.

Dust sampling, therefore, cannot be as generalized as it may be in other types of mining. What applies to a miner cutting coal on the third level of a mine may not be comparable to a similarly employed miner on the fifth level.

When we consider the limited number of samples that are made available to us by the people active-ly engaged in dust sampling, we realize the need for co-ordination within the Department, between the sampling agency and the inspection ageneies. Nothing said here is meant to imply that the dust sampling people are lacking in diligence. Quite the contrary. I have made an exhaustive study of the procedure and work effort of our dust sampling personnel, and aside from certain suggestions made as to streamlining of reports, I feel that a good job is being done by all concerned.

Co-ordination of dust conditions is a subject with a broad seope, and many facets, each equally im-portant.

Our first duty is, of course, remedial action in cases where dust concentrations and qualities indi-cate the approach to or surpassing of the "Threshold Limit". We immediately notify the mine inspector who, in turn, visits the operation in order to establish corrective proccdure. By implieation, at least, he is instructed to establish corrective action in all similar cases in his district, even though the dust sam-plers have not been in all places of like quality. You realize, of coursc, that dust sampling is purely on a representative base, that a specimen miner eutting coal is observed during an entire day at work, assum-ing that other miners working in similar conditions are similarly exposed.

Up to Oetober 9, 1964, a total of 1791 samples wcre taken in 27 Anthracite Mines. One hundred and twelve (112) samples were over the "Threshold Limit". Seventy-six (76) were rechecked, and in every case the condition causing the high dust concentration had been correeted. The remaining thirty-six (36) were not reehecked because the time weighted average exposurc was well under the "Threshold Limit", indicating that the obnoxious condition was only momentary. In every case, however, the Mine Inspector was notified.

Through the medium of the mine inspector, both supervision and workmen are made aware of the con-ditions producing the hazard, and of the nature of the eorrective measures required to abate the hazard.

As all three parties, inspeetion, management and labor are well aware, eorrective measures are not always simple. Dust originates from such sourees as drilling, cutting, loading, eoal sliding or falling down pitching places, blowing off cars in high velocity or currents, etc. Generally speaking, in flat work, adequate water sprays, and sufficient ventilation produee the required results. In steeply pitehing seams, however, both labor and management are resistive if the use of water produces a slippage hazard likely to cause accidents. In these instances, co-ordination of thought and effort by all three parties is often necessary to achieve the desired result.

In order to make proper use of the information acquired through sampling and subsequent corrective measures, it is necessary that there be adequate dissemination of information between the Department and the Mine Inspectors and between the Mine Inspectors. It is readily apparent that a lesson learned in one mine may well apply to many more mines. Proper exchange of information may well result in corrective action where necessary, long before the dust sampling people get around, with consequent reduction of exposure.

As you are probably aware, the Secretary of Mines and Mineral Industries distributes the results of all dust studies to the District Mine Inspector, the Department of Health, the proper Labor Organizations and Management. This spread of information makes possible further study and interpretation of the collected data, along with contributing to the general knowledge of the situation.

One additional facet of co-ordination appears to be that of arranging dust sampling studies in relation to X-ray examinations. We recently learned, by accident, that the Mobile Unit was in operation in our area. We immediately directed our sampling efforts to this general area, with the thought information acquired concurrently with physical examinations might be of value when compared to future similar studies.

If this thought has any value, closer co-ordination between the physical examinations and the dust sampling efforts can readily be established by a simple exchange of information between the various agencies.

THE ROLE OF THE MINE INSPECTOR IN DUST CONTROL IN ANTHRACITE MINES

Willis R. Devens, Anthracite Mine Inspector
Department of Mines and Mineral Industries, Forty Fort

The Anthracite Mine Inspector - by law - is charged with seeing to it that the provisions of Mining Laws are observed and obeyed. Dust, as such, is mentioned specifically in only one portion of the laws. This is in the provision that, when the coal-dust in a breaker is "so dense as to be injurious to health", - - measures must be adopted, upon the request of the Inspector, for the removal of the dust.

However, when the authors of our mining laws were setting up ventilation requirements for the protection of the health and well-being of underground workmen - and this was in 1891 - they used such terms as can only be construed to mean - guard against any dangerous or harmful contamination of the air. The law places a burden on the Owner, Operator, or Superintendent, to provide and maintain a, "constant and adequate supply of pure air", for each and every person. And the ventilating currents must be, "conducted to and along the face of each and every working place throughout the entire mine, in such quantities that smoke and noxious or dangerous gases are diluted, rendered harmless, and swept away - - - to the extent that all working places and traveling roads shall be in a safe and fit state to work and travel therein." The authors did not spell out for us the absolute quality of pure air, but through the years this simply worded paragraph has enabled the Inspector to demand that all atmospheric contaminants be kept to safe limits. Certainly the terms, "pure air", and "safe and fit state" do not permit conditions wherein the workman inhales excessive quantities of air-borne dust. The Anthracite Inspector does not, due to the low-volatile content of our coals, concern himself with the aspect of explosions of coal dust, as there are no records of such, - but rather with the hazards of low-visibility and danger to health and well-being.

The Inspector learns of the presence of a dust-hazard in one of several ways:

He notes particular hazards during his regular safety inspections; all working places are inspected at least once in every two months. Although carrying no equipment with which to take dust-samples or make counts, in most cases he is able to spot where the dust concentration is very much above the recognized Threshold Limit Values by the presence of such obvious dust-producing factors as the dry nature of the coal seam, the omission of the application of water during cutting, drilling, before and after blasting, etc., and through reduced visibility. He thereupon orders abatement, and from his experience, will suggest such improvements as he feels will accomplish the necessary control.

He may receive a complaint from the workmen, such as that needed water is not being supplied - or that other workmen on the same split of air are not using the water in their places - or that ventilation is not adequate, etc. Each complaint is investigated. If conditions are as they have been represented, the Inspector orders that they be corrected; at the same time he impresses the seriousness of the hazard on all persons concerned, in an effort to provide that conditions will remain corrected.

Or, the Inspector receives notification in writing from the Secretary of Mines and Mineral Industries, of the discovery of concentrations of air-borne particles of coal and silica in the mine, in such combination and quantity as to exceed the accepted Threshold Limit Values for Mineral Dusts. This notice will have been based on the results of dust samples taken and analyzed by personnel of the Department during one of their periodic dust studies at the mine. With this notice the Inspector also receives a complete file showing the qualitative and quantitative results of all samples taken during the study, good or bad, and also pertinent information as to the kind of work being done, mining equipment being used, and the type of dust-control measures, if any, which were being used. By comparative use of this information, the Inspector tries to determine the probable factors making for the excessively dusty conditions set forth in the notice. He immediately visits each of the cited places, and determines if - as is often the case - steps have already been taken to correct the condition; if not, he orders abatement and renders any

assistance he can in pointing out which dust-control measures are needed. In any event, when it appears that the desired improvements have been obtained, he notifies the Secretary, who will thereupon send someone to take check samples. Usually, but not always, these samples show that there has been sufficient reduction in the number of air-borne particles - if not, additional adjustments are made in the dust control or mining, further check samples obtained, etc., until Threshold Limit Values are met.

In recent dust studies which have been made in the mines of my District, those samples which have indicated that dust concentrations were too high have been on the order of from zero to five percent of the total. Mostly, they have involved drilling without water in coals which were thought to be naturally damp, and have been border-line cases. But some have been very high, usually those taken where a shearing machine was being used without the proper application of water. One was due to such a remote cause as the rubbing of a pull-rope on a coal rib.

In every case, conditions have been remedied promptly, either before or shortly after the Inspector's visits. There has been excellent co-operation from top management, who in most cases are thoroughly familiar with the problem as a result of their own engineering studies, and from the literature. However, we find that conditions which have been corrected following their discovery by inspection, complaint, or dust-sample, have not always remained corrected. Also, new installations are not always set up properly with regard to dust control. Perhaps someone low in the chain of supervisory command has - at least by his tacit consent - permitted a good dust-control program to fail, because either he or his crew, or both, do not wish to stop production long enough to allay the dust. Some of the factors the Inspector looks for where there has been back-sliding in the dust-control program are as follows:

Not waiting long enough after blasting for the ventilation current to sweep away the dust and fumes.

Not spraying before blasting.

Not using solid-cone spray nozzles.

Not spraying the proper side of cutter-bar on shearing machines.

Not using water in pitch work, for fear of making slippery footing.

Reservoirs too small to last through-out the shift.

Failure to prevent spillage of coal during transportation.

Not using the water at all in cases where its use would benefit only "the other fellow".

At this late date, I do not think that the answer to our problem lies in education. Everyone seems to be pretty well informed as to the danger from continued exposure to excessive quantities of air-borne dust. In fact, we are often told during inspections that this or that crew will not work unless they have the water. Unfortunately, it sometimes appears that this is true of only one portion of the work cycle - they are not so eager to use the water in all operations.

Rather than educate - although we should continue to do this to catch the new employee - I think that supervisors and inspectors will have to more or less take off the gloves and provide a better enforcement of our existing mining laws, with regards to keeping our work-areas in a "safe and fit state". Just making sure that everyone understands the hazard will not, in itself, make us all stay out of excessively dusty atmospheres - any more than education on lung damage has made us all quit smoking tobacco.

In this discussion, I have tried to describe the role of the Anthracite Inspector in dust-control. But I have also presumed to set forth some of his thinking. I do this only after forty years experience in Anthracite mines, during which time I have at some time been associated with practically all of the Governmental and Industrial mine inspectors. I recall how we have gone on from learning - in about 1933 - that rock dust was not the only injurious dust in our mines, and our participation in the joint studies of 1942 in which we were made aware of the presence of dust particles too small to be seen and too small to over settle out without help.

From this long association with the men of the various inspection agencies, I think I can safely say that we all understand the seriousness of the dust problem, and that we all will continue to press for healthier working conditions.

INTERPRETATION OF ENVIRONMENTAL DATA COLLECTED BY THE DEPARTMENT OF MINES AND MINERAL INDUSTRIES

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The Department of Health began an investigation of coal workers pneumoconiosis in 1958. There had been an increasing awareness that a serious health problem existed in the Pennsylvania coal industry. As Governor Scranton mentioned yesterday, of all the reported deaths from pneumoconiosis in the country, approximately 55 per cent occur in Pennsylvania. From the economic standpoint, money paid by the State to coal workers and their survivors in pneumoconiosis awards amounts to over 1½ million dollars per month.

The only published epidemiological assessment of this problem in Pennsylvania was in 1934. At that time, and this was also mentioned yesterday, the U. S. Public Health Service, at the request of the Governor of Pennsylvania, conducted a study of the medical and environmental aspects of anthraco-silicosis in three selected anthracite mines. Among the conclusions and recommendations in their final report were suggestions for exposure limits to dust in coal mines. These were based on the percentage of free silica contained in a total of 11 selected dust samples collected at three mines. While this study was a noble undertaking, it was unfortunately a limited one. Actually, the proposed limits approximate the present threshold limit value for silica-bearing dusts. The additive effect of mixture of coal and silica dust were not considered at that time. Since claims of miners for chest diseases are increasing, there is reason to suspect that either dust conditions had not improved in the mines or the dust standards proposed in the study had not been adequate.

From 1958 to 1960, the Division of Occupational Health performed dust studies and made environmental measurements in 24 anthracite and 14 bituminous coal mines. The immediate goal of our activity was to determine the relative dustiness of the various mining operations; consequently, there were only a few weighted average exposure studies done on specific occupations during this initial phase. The long-range goal was to conduct an epidemiological study of coal workers' pneumoconiosis in which weighted average exposure data would be compared with medical data in order to establish dust limits based on exposures to combinations of coal and silica dusts.

In 1960, the Department of Mines and Mineral Industries assumed the environmental phase of the pneumoconiosis activity. It became that department's responsibility to perform the weighted average exposure studies needed in our comparison study. The Department of Health continued the medical phase, i.e., chest X-rays, lung function tests and occupational histories of coal workers. The Division of Occupational Health continued to provide laboratory services for the analysis of the free silica content of mine dust samples and has maintained close liaison with the Department of Mines and Mineral Industries. The liaison has been in the form of conferences and review of survey reports with the Deputy Secretaries and conducting training sessions for the chief mine foremen.

In an epidemiological study of coal workers, the parameters of the environment which cause pneumoconiosis must be evaluated to determine the degree of exposure of a coal worker throughout his working lifetime. In the United States these parameters are the number of respirable particles per cubic foot of air and chemical composition of the airborne dust, particularly the free silica content.

The Division of Occupational Health tabulates data obtained from survey reports of the Department of Mines and Mineral Industries. The data include weighted average exposures of coal workers, the particle size distribution of the dust, the free silica content of the dust and the relative humidity found in the coal mines. These data are indexed by occupation, coal region and coal seam. If medical data are available for the particular mine, a comparison with environmental findings is made. Occupational histories are arranged chronologically to show the number of years worked in specific occupations and mines.

The history of the mine is then searched to determine the average number of days worked during the exposure period.

The weighted average exposure data from the mine survey reports give the occupational dust exposure per day. When the daily exposure is applied to the average number of days worked per year, we have the average dust exposure per year. The total number of years worked at each occupation gives the dust exposure per working lifetime. By plotting dust exposure per number of years versus effect, in terms of disease, an index is obtained which can be used to develop usable standards for determining the degree of dust exposure which should not cause pneumoconiosis. This limit would then be used to assess the degree of hazard and to maintain control.

At the present time we do not have sufficient information on which to base a standard. We have only trends. In addition to more information, we need time to evaluate the effects of the present dust conditions. With an expanded pneumoconiosis prevention activity we should be able to realize our long-range goal in 5 years. This means a larger field staff for both the environmental and medical phases as well as increases in research and evaluation staffs.

To conclude, we do not feel that the dust limits proposed in the 1934 study or the threshold limit value for silica dust are applicable for coal dust. Since these are all we have at the moment, they are, of course, being used. The epidemiological study is, therefore, a beginning toward establishing this needed limit and in preventing coal workers' pneumoconiosis.

PHILOSOPHY OF AIR SAMPLING FOR CONTROL OF DUST IN COAL MINES

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Introduction

Fifty years ago in many dusty industries, workmen were exposed to massive concentrations of airborne mineral dust. It was not uncommon to find pneumoconiosis in 30 to 80 percent of the men examined in the dusty trades (1). When the dust was both high in concentration and contained a high proportion of free silica, severe disease might develop with a very few years exposure.

During the 25 or 30 years preceding World War II a number of studies were conducted on the prevalence of pneumoconiosis, methods were developed for measuring levels of exposure, and substantial efforts toward dust control were made in many industries (2-12). Changes in prevalence of pneumoconioses, with the trend toward reduced rates, which have been seen in successive studies in some dusty industries during the past five decades, are probably the result of a variety of factors including differences in the definitions of populations studied, improvement in technical quality of chest x-rays, changes in diagnostic practices, and legislative or regulatory changes which affect eligibility for compensation. The major reason for lower prevalence of disease, however, is undoubtedly improvement in working conditions, specifically reduction in the quantity of dust to which workmen are exposed.

The Impinger Method

The reduction of exposures to dust requires a means of assessing exposures. Since the etiologies of the pneumoconioses are not fully known, it is not possible to define all of the characteristics of mineral dusts which contribute to their toxicities or biologic effects. All of the sampling methods used in different parts of the world for estimating exposures to dust are, therefore, empirical. None is an absolute method which will yield data from which the hygienic significance of exposures can be precisely judged.

In the United States, the American Conference of Governmental Industrial Hygienists promulgates Threshold Limit Values for toxic materials for use by industrial hygienists as guides in devising adequate control of occupational exposures. Threshold Limit Values have been developed for a number of mineral dusts. These values for mineral dusts can be used to judge only data yielded by a standard procedure of impinger sampling in liquid medium and light-field microscopic counting of the collected dust; the Threshold Limit Values cannot be applied to data from other methods of sampling.

There is no American Conference of Governmental Industrial Hygienists Threshold Limit Value specifically for coal dust, and the standard method of impinger sampling and light-field counting was not developed with measurement of exposures to coal dust in mind. The method is, however, used in assessing dustiness in coal mines by various agencies and industrial units concerned with the exposures of workmen to dust. Rules of thumb, or the American Conference of Governmental Industrial Hygienists Threshold Limit Value for silica-bearing dusts, are used by some investigators as guides in interpreting exposure values yielded by this impinger sampling.

The standard method for impinger sampling and counting was presented in 1942 at a meeting of the National Conference of Governmental Industrial Hygienists (13). Because the method is empirical, it must be followed closely by all its users if data obtained by one person is to be comparable to that obtained by another. Even then, variables in sampling and counting within the method as it is described, may permit two investigators, both applying the method skillfully and conscientiously, to obtain quite different results to represent the same environment.

Field Techniques in Sampling

Sampling may have different purposes which merit different techniques. These generally fall into two major categories: (1) sampling for engineering surveillance, testing, or control; and (2) sampling for health research or epidemiologic purposes. Engineering applications of sampling may include locating sources of contaminant, monitoring performance of environmental control systems, or research in such problems as collection efficiencies of air cleaners. A sampling program for engineering purposes should be designed to yield the specific information desired. For example, one might need only single samples before and after a change in ventilation to determine whether the change has had the desired effect. Hygienic applications of sampling, on the other hand, may be directed at predicting the health effects of an exposure by comparing sampling results with hygienic guides; determining compliance with health codes or regulations; or research to define as precisely as possible environmental factors for comparison with observed medical effects. In the latter case, sampling may provide the basis for development or refinement of hygienic guides such as Threshold Limit Values.

Among the variables which should be considered in the sampling procedure are variations in the rate of generation of respirable dust, and the direction of air motion with respect to the dust source, the person exposed, and the sampling location. The choice of sampling location is largely dependent upon these factors. For example, as a machine advances in a work place, as ventilation air currents change with this advance or from other changes in the mine, as a workman moves from place to place in the course of his work routine, his actual individual exposure could be quite different from the concentration measured at some arbitrary fixed location in the working place. Thus, in sampling for hygienic purposes, it is often necessary to collect the sample from the breathing zone of the worker. This requires that the sampling device be kept as close to the workman as possible and that the air which it captures be representative of the air which he actually breathes.

It should be kept in mind that only particles smaller than about 5 microns appear to be significant in producing pneumoconioses and that such particles move with air currents. Their motion in turbulent air is little affected by their momentum or by gravitational settling. The microscopic particles most efficiently captured by the lungs are about 1 micron in size. A 1 micron particle released with a velocity of even 100 miles per hour in still air would come to rest in a distance of less than 0.01 inch and such a particle has a terminal settling velocity of about 1/8 inch per minute. Air motion, then, is all important in the movement of fine dust.

In assessment of dust exposures which fluctuate with time the number, duration, and time scheduling of individual samples is highly important. In assessment of daily exposures using samples of short duration such as impinger samples, the relative contribution of the dust concentration determined for any particular portion or operation of a work cycle is proportional to the fraction of time of the total work cycle represented by the operation. Each part of a work cycle should be sampled. The mathematical summation of the products of dust concentrations and fractions of the 8-hour working day for each of his operations or activities of the day would thus represent the exposure of a workman for that day. This composite value is called his time weighted average exposure.

Many samples over several days of operation may be necessary to make a time weighted assessment of a variable exposure for hygienic purposes. All too frequently, the significance of an exposure is judged on the basis of too few samples of too short duration. Tomlinson, (14) Ashford, (15) and Hodkinson, (16) among others, have dealt with various aspects of this problem. Roach (17) has proposed the use of sampling times no more than 1/24 the biologic half time of a substance when results of greatest hygienic significance are being sought. For mineral dusts with long half-times he suggests that samples be no less than a full working shift in duration. Single impinger samples of such duration are not practical, and more work is needed in the development of sampling strategy to accommodate this facet of the problem.

Respirable Dust Sampling

Sampling for atmospheric particulates presents problems quite different from those encountered in sampling for gases and vapors. Gases and vapors, when inhaled, can penetrate all portions of the pulmonary system and follow the laws of distribution by diffusion and absorption. The size and density of particles, on the other hand, strongly influence the site at which they will be deposited in the pulmonary system. Since the effect which may be produced by particles trapped in the nasal passages or deposited in the ciliated portions of the pulmonary system may be quite different from that of particles which penetrate and are deposited deeper in the pulmonary system, size-selected sampling is generating increasing interest among industrial hygienists. At the Penumoconiosis Conference held in Johannesburg, South Africa, in 1959, in which experts in pneumoconiosis from all over the world participated, it was concluded that in the light of present available evidence the best single parameter to measure in the case of coal dust is the mass concentration of respirable dust, and in the case of quartz dust, is the surface area of the respirable dust. (18) The respirable fraction of a dust cloud was then defined as all particles smaller than 1 micron, half those of 5 microns, and none of those 7 microns or larger equivalent diameter. The equivalent diameter of a particle is that of a unit density sphere having the same falling velocity in air as the particle.

Sampling devices designed to reject particles too large to penetrate to the deeper portions of the lung, or to collect these larger particles in a pre-sampler, with the respirable portion collected separately for weighing or analysis have been developed. The Conicycle (19) developed by the Medical Research Council of Great Britain, is representative of the rejection type sampler. Presampler types are the Hexhlet (20) gravimetric dust sampler developed by the same council and the two-stage cyclone-filter type samplers developed by the New York Operations Office of the Atomic Energy Commission, the Los Alamos Scientific Laboratory, (21) and in Germany (22). The results of sampling for pneumoconiosis-producing mineral dusts, either for gravimetric determinations or for determination of composition, cannot be interpreted by use of our current Threshold Limit Values or similar guides for judging exposures. Such sampling however, may represent a sensitive method for predicting the disease-producing potential of exposures to mineral dust and is worthy of further study.

It has been repeatedly demonstrated that the composition of fine dust which can reach the lungs is not necessarily the same as that of the total airborne dust which contains larger particles. Effects produced in the lungs are in all likelihood produced by material which reaches the lungs, and are influenced little or not at all by the larger particles which are captured by the upper respiratory system. There seems to be little question, then, that samples yielded by size-selective samplers designed to simulate the deposition characteristics of the lower pulmonary system, have great value in studies of dust composition in epidemiologic research. The accumulation of data using such devices, with design and operation based on agreed lung deposition criteria, sampling in parallel with our standard dust sampling devices, will permit eventual judgment regarding their usefulness.

The present state of dust sampling technology is well defined by the concluding paragraph of the excellent new book, "Pulmonary Deposition and Retention of Inhaled Aerosols", by Hatch and Gross (23). These authors state:

> "There is no firm and final answer to the question: how best to collect aerosol samples and how to express aerosol concentration and composition. Indeed, there is no one best procedure since the nature of the relationship between the inhaled aerosol and the disease risk, which is mediated in large measure by the behavior of the particles in the respiratory system, differs so much from one disease to another. It seems clear that the relatively simple sampling procedures and analytical methods which were employed successfully in dealing with the relatively gross dust hazards of the past cannot be depended on to fully meet the needs of the future."

Summary

The control of exposures to dust requires a means of assessing dust concentrations in the air. Methods which are used for sampling and quantitating dust concentrations are empirical and results yielded by one method cannot be judged by standards based on another. Even with a single method, for example the impinger sampling and counting method, differences in application can cause differences in results obtained by two investigators.

Dust sampling may be undertaken for either of two rather distinct purposes, for engineering testing and control or for health studies. The objectives of the sampling program should be kept well in mind while it is being planned and carried out.

Human lungs are size selective dust samplers. Only relatively small particles, generally those less than 5 microns in diameter, reach the alveolar spaces. Such small particles move with air currents; they settle very slowly in still air and even when thrown into the air with high velocity they travel through the air only a short distance. Dust concentrations may vary with both time and location. It is often necessary to sample in the breathing zone of a workman to determine his exposure and the amount of time he spends at each different level of exposure must be considered in determining his weighted average daily exposure.

Because only the relatively fine dust reaches the lungs, size-selective sampling devices intended to simulate the deposition characteristics of the lungs have been developed. The mass concentration or surface area of particles of such size that they penetrate to, and are deposited in, the deeper portions of the lungs may prove to be a sensitive index of hazard from exposures to pneumoconiosis-producing dusts. Although data derived from such sampling cannot be interpreted by standards based on count, size-selective gravimetric sampling may eventually represent a major refinement in assessment methods.

References

1. National Silicosis Conference: Final Report of the Committee on the Prevention of Silicosis Through Medical Control. U.S. Dept. of Labor Bull. No. 21, Part I. Washington, 1938.

2. Higgins, E., A. J. Lanza, F. B. Laney, and G. S. Rice. Siliceous Dust in Relation to Pulmonary Disease Among Miners in the Joplin District, Missouri. Bureau of Mines Bull. 132, 116 pp., 1917.

3. Harrington, Daniel and A. J. Lanza. Miners' Consumption in the Mines of Butte, Montana. Bureau of Mines Tech. Paper 260, 19 pp., 1921.

4. Hoffman, F. L. The Problem of Dust Phthisis in the Granite-stone Industry. U. S. Dept. of Labor, Bureau of Labor Statistics, Bull. 293, Washington, 1922.

5. Sayers, R. R., F. V. Meriwether, A. J. Lanza, and W. W. Adams. Silicosis and Tuberculosis Among Miners of the Tri-State District of Oklahoma, Kansas and Missouri. I. For the Year Ended June 30, 1928. Bureau of Mines Tech. Paper 545, 30 pp., 1933.

6. Meriwether, F. V., R. R. Sayers, and A. J. Lanza. Silicosis and Tuberculosis Among Miners of the Tri-State District of Oklahoma, Kansas and Missouri. II. For the Year Ended June 30, 1929. Bureau of Mines Tech. Paper 552, 28 pp., 1933.

7. Sayers, R. R., et al. Anthraco-silicosis Among Hard Coal Miners. Public Health Bull. No. 221, U. S. Public Health Service, 1935.

8. Flinn, R. H., et al. Silicosis and Lead Poisoning Among Pottery Workers. Public Health Bull. No. 244, U. S. Public Health Service, 1939.

9. Flinn, R. H., et al. Soft Coal Miners' Health and Working Environment. Public Health Bull No. 270, U. S. Public Health Service, 1941.

10. Russell, A. E. Health of Workers in Dusty Trades, Restudy of Granite Workers. Public Health Bull. No. 269, U. S. Public Health Service, 1941.

11. Ellis, P. M., M. T. Smith, H. E. Bonebrake, and L. B. Hunter. Silicosis. General Considerations and Survey in the Coeur D'Alene Mining District of Idaho. North West Medicine, Vol. 41, 406 pp., December 1942.

12. Dreessen, W. C., R. T. Page, J. W. Hough, V. M. Trasko, J. L. Jones, and R. W. Franks. Health and Working Environment of Non-ferrous Metal Mine Workers. Public Health Bull. No. 277, Washington, 1942.

13. Transactions of the Fifth Annual Meeting of the National Conference of Governmental Industrial Hygienists. Sub-committee on Standard Methods, Washington, D. C., 1942.

14. Tomlinson, R. C. A Simple Sequential Procedure to Test Whether Average Conditions Achieve a Certain Standard. Applied Statistics, VI, No. 3:198, 1957.

15. Ashford, J. R. The Design of a Long-Term Sampling Programme to Measure the Hazard Associated with an Industrial Environment. Jour. Royal Statis. Soc., 121, Part 3, 333, 1958.

16. Hodkinson, J. R. Reproducibility and Correlation of Long-Period and Short-Period Thermal Precipitator Samples of Airborne Dust in Mines. Ann. Occup. Hyg., 2:235, 1960.

17. Roach, S. A. The Importance of Body Burden in Establishing Hygienic Standards. Presented at 2nd International Symposium on Permissible Limits for Air, Paris, April 1-6, 1963.

18. Proceedings of the Pneumoconiosis Conference, Johannesburg, 1959, J & A Churchill, Ltd., London (Little, Brown & Co., N. Y.), 1960, p. 620.

19. Wolff, H. S., and S. A. Roach. The Conicycle Selective Sampling System, Inhaled Particles and Vapors, C. N. Davies, Editor, Pergamon Press, London, 1961, p. 460.

20. Wright, B. M. A Size Selecting Sampler for Airborne Dust. Brit. Jour. of Industr. Med., 11:284, 1954.

21. Hyatt, E.C., et al. A Study of Two-Stage Air Samplers Designed to Simulate the Upper and Lower Respiratory Tract. Proceedings of the Thirteenth International Congress on Occupational Health, New York, 1960, p. 486.

22. Breuer, H. A Filter Device for Selective Sampling in Coal Mines of Respirable Fine Dusts, Inhaled Particles and Vapors. C. N. Davies, Editor, Pergamon Press, London, 1961, p. 453.

23. Hatch, T. F., and P. Gross. Pulmonary Deposition and Retention of Inhaled Aerosols. Academic Press, New York, 1964. P. 172.

CRITICAL FACTORS IN THE EVALUATION OF DUST EXPOSURES IN BITUMINOUS COAL MINING

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Participation in, and attendance at, this Governor's Conference on Pneumoconiosis provides all of us the opportunity to exchange information and advance our knowledge on fine particle measurement in air (aerosols), interpretation of such measurements in terms of the potential health and explosion hazard and the type of potential health problem which may arise from excessive inhalation of such airborne particulates. At this moment, regardless of our affiliation, we should have one dedication, namely, the improvement of the health of our mining population. In this quest, we are all health workers.

While the time allotted to each of the speakers is indeed limited, I believe a few prefacing comments are pertinent. First, a brief quote from one of the reports of the Medical Research Council of Great Britain of their intensive study entitled, "Chronic Pulmonary Disease in South Wales Coal Miners," published in 1943. In the report on the environmental phase, the following statements appear, which are fundamental in any investigation of the effect of an environment on health:

> "Thus, in coal mines, it is a simple though laborious task to make an adequate survey of present-day working conditions . . . . . But, it does not follow that the thermal conditions and the dust concentrations measured in the last two or three years truly indicate the conditions that have prevailed for a period of perhaps twenty years or more, during which the miners now suffering from pulmonary abnormalities have been contracting their disability."

I would believe that most investigators would now take exception to the expression on the simplicity of evaluating work conditions underground. However, the comment on the relationship of present dust conditions to present pulmonary findings is factual and will remain true in the future. In other words, the assessment of present-day work conditions in coal mining cannot be made upon the basis of present chest x-ray or other medical findings.

Second, any assessment of coal dust should not limit itself solely to effects upon the respiratory system, but must also be evaluated in terms of the potential explosion hazard, due to the presence of methane. A much larger size range of airborne dust is involved in the latter potential problem which is expressed in terms of a weight concentration. This broader scope of interest in any coal mine investigation is important for several reasons, among which is the fact that the control of respiratory hazard may not result in control of the gas and explosion potential. This is particularly significant with present mining methods, which result in a higher rate of face advance and coal extraction.

Finally, a brief comment about the efforts and interest of the coal industry in this area of dust and gas control and the need to carefully interpret reports in the literature. I can only speak with some authority on the activities within the United States Steel Corporation, but I believe that one may safely hazard an opinion that other coal producers are also directing much attention to this potential problem. A recent report [1] on silicosis in the metal mining industry by the U. S. Bureau of Mines and the U. S. Public Health Service revealed a marked reduction in the prevalence of silicosis. While the report does not imply that the problem has been eliminated, it recognizes that considerable progress has been made. It is believed that the coal mining industry has also made significant progress. Of course, we are and shall continue to seek improvement of methods. But, the evaluation of present mining practices in terms of their relationship to pulmonary findings in miners will require many years of extensive investigation. This statement is well supported by the work in Great Britain by the National Coal Board and the Safety in Mines Research Establishment (SMRE). The comprehensive investigations of the National Coal Board have been conducted by a staff, which in 1958 consisted of 400 samplers and more than 200 laboratory workers, and have been underway for about seventeen years. The standardization of methodology in assessing dust exposures

and the elimination of disabling respiratory disease, are still major challenges to their very able medical and scientific teams of investigators. Nagelschmidt [2] of SMRE states, "In Western Europe, pneumoconiosis is the most important of all industrial diseases, in the sense that it affects the largest number of men. In particular, this applies in Britain, Western Germany, France, Belgium and Holland to pneumoconiosis of coal miners."

I would like to briefly mention some of the work we are doing within United States Steel. For example, during about the last five years, our industrial hygiene staff, working with our coal management, have been intensively engaged in the assessment of the dust and gas conditions in our operations. However, even prior to our assignment to this investigative area, our mining divisions were involved in this work for many years. Within the last two years alone, our staff has collected about 5500 air samples for so-called "float" dust. While the great majority of these samples has been collected in the breathing zone of the continuous mining machine operator (CMO), dust samples are obtained ahead of the operator (CMO) for both a weight and particle count determinations, and in other areas, for both health and explosion evaluation. We are now engaged in an extensive study to determine the effects upon dust concentrations and the optimum application of the following variables:

a. water pressure
b. whirlplate size
c. nozzle type and size, number, and location
d. application of water to the cutting edges
e. application of wetting agents
f. methods of face ventilation

The longer we continue with this program, the more we realize the relationship of these variables and the need for more and more data before expressing our opinions. The scientific teams of the National Coal Board in England have also found this almost insatiable requirement for data, because of the magnitude of the number of variables and of the effect of each to dust and gas production. A large number of papers have appeared in foreign and American scientific journals, particularly in Great Britain. Conclusions are drawn which a few years later are considerably altered as more experience is gained with a method of assessing the problem or with a specific control measure. Therefore, we must carefully equate these reports in terms of American mining practices and not overlook the excellent contributions of the U. S. Bureau of Mines and U. S. Public Health Service to our knowledge of dust evaluation generally, and to coal mining in particular, for about thirty years.

Measurement of Airborne Dust

Before discussing some critical factors in assessment, a few remarks would be pertinent on some of the terminology used in dust assessment and the criteria for evaluating the measurements. I am assuming that a number of mine operators, equipment manufacturers, mine engineers, and labor representatives may be present. If this audience comprises primarily industrial hygiene and medical personnel, a major objective of this Conference has not been met, namely, informing the uninformed.

The industry speaks of "float dust". I would imagine that if each of us had to define this term as to its particle size, we would have as many answers as individuals. What is float dust and is it a proper term within the parameters of aerosol technology? In my opinion, it is a poor term. What will "float" and be carried in an air stream depends on density, surface area, and speed of the air currents which must carry it. I have only recently seen a definition of the term [3] which states that it is applied to coal particles of less than 74 microns. Particles in the upper range of this size are considered "rocks" among those evaluating airborne dust in terms of potential health hazard. In our measurement of airborne dust particles in returns, 90% was less than 5 microns and this is in quite good agreement with other investigators. A 50 micron (μ) spherical particle of unity density will settle in still air at a rate of about 16 ft/min. Still air is generally considered to have a velocity under 25 ft/min. Therefore, such a coarse particle will not remain suspended in air very long, unless considerable air movement is present.

In aerosol technology, the size unit is the "micron (μ)" which is 1/25000 of an inch. As a rough index of the particle size of interest, the human hair is about 60-80 microns in diameter. Dust concentrations for health hazard evaluation are stated in terms of million particles per cubic foot of air (mppcf) in this country, and particles per cubic centimeter (pcc) in England. The latter can be converted to the former by dividing by 35.3. As the explosive limits of coal is expressed in terms of ounces per cu. ft., this is merely a weight determination which is quite easily obtained.

Purpose of Measurement

The purpose of dust measurement in coal mines is to evaluate the health and explosion hazard potential. The measurement must reveal data for comparison with the criteria by which hazard levels of dustiness are expressed. This criteria, known as "maximum allowable concentrations" has been developed from joint medical and engineering studies of workers and their environments, in various industries by the U. S. Public Health Service, the U. S. Bureau of Mines and other survey teams. They represent levels of dustiness to which a worker may be exposed over his lifetime which will not result in adverse effects upon his respiratory system. In other words, the criteria is biological rather than physical. Therefore, the entire dust assessment procedure for health hazard evaluation which involves the sampling instrumentation and procedure and the analytical instrumentation and procedure must provide data in a form which will allow biological interpretation. It is not merely an exercise in the technology of aerosol particulates.

Allowable Concentrations of Dustiness

Criteria representing maximum allowable concentrations or threshold limit values for bituminous coal dust has been developed primarily from studies of the two previously mentioned federal agencies. The U. S. Bureau of Mines recommends the following: 4/

> "In bituminous and lignite mines the average full shift concentrations of atmospheric dust to which a workman may be exposed should not exceed 20 million particles per cubic foot of air and a maximum concentration for any single operation should not exceed 40 million particles per cubic foot of air. When the dust contains silica, not more than 5 million particles of silica dust per cubic foot of air should be present in the above limited concentrations."

Today, the American Conference of Governmental Industrial Hygienists is the principal source of information on "maximum allowable concentrations," or "threshold limit values", of all potentially hazardous aerosols. Its annual list of Threshold Limit Values (TLV) does not contain a value for coal dust. It lists a value for nuisance dust of 50 mppcf and the following formula for calculating such values for silica-bearing dusts.

$$TLV = \frac{250}{\% SiO_2 + 5}$$

If we assume a free silica content of 2% for airborne dust at the working face of a bituminous coal mine, the TLV would calculate out at about 36 mppcf. In Great Britain, criteria was developed by the Medical Research Council and the National Coal Board entered into an agreement, in 1947, to conform to these levels of dustiness. These levels are shown in Table-1 and are quite well in agreement with those proposed by the U. S. Bureau of Mines.

It is pertinent to point out a few facts about the application of these criteria. First, in this country, they are based on samples collected with an impinger and counted by the light field technic which would appear to exclude direct reading instruments. In Great Britain, the thermal precipitator is the sampling instrument. Second, our criteria for dust hazard evaluation in coal mines is based upon the time-weighted average concentration and not upon the mean average or median dust concentrations. In Great Britain, this factor was not originally defined when their standards were developed. If one can assume that the

practice followed in 1959 still prevails, a working place is approved, provided that the approved levels are not exceeded on more than one shift in ten. 5/ On the assumption that the shift to shift variations are of the order of ± 40%, the 850 particles per cubic centimeter corresponds to an average figure, over a month or more, of 700 particles per cubic centimeter. Tests of approval were than worked out in terms of this average, and it was urged that, in the future, all critical levels of dustiness should be stated on the basis of such average values. I am not familiar with the practice today, and it would not be surprising that a different practice is in force, for shift to shift variations in excess of 40% no doubt exists.

It should be noted that in Great Britain, only the dust particles 1-5 microns in size are considered. There is considerable documentation of the soundness of this practice. In the United States, this size range is likewise used, although in the original establishment of the standard, the upper limit of the size range was 10 microns.

Critical Factors

The meaningful measurement of airborne dust in coal mining operations is no simple task. Of course, the mere operation of an instrument is simple, but its application to securing representative data and the interpretation of such data requires one with training and experience. Because the so-called standard technic -- impinger and subsequent counting methods -- is tedious and time-consuming, some investigators succumb to the desire to undertake short cuts at the expense of accuracy and validity of data. In assessing dust in coal mines, this inaccurate practice can be completely wasteful and may even be hazardous. In dust surveys for determining the health hazard potential, the investigator must be cognizant of the fact that his physical determinations are only of value, if they allow interpretation of the effect upon the respiratory system (biological effects).

Dust assessment in coal mines should reveal the following information:

1. Dust concentration by count and weight

2. Composition of the dust, both chemical and mineralogical

3. Particle size distribution

4. Distribution of the miner's time in each phase of his work procedure

It is in the inadequate attention to several critical factors in obtaining this data and their significance to the potential problems under investigation that serious errors may arise. In addition, unless one has some experience with coal mining practices and the means of applying the measures employed for control of the potential hazards, he may lack sufficient appreciation of the difficulties encountered in obtaining the data. The knowledge which one must acquire consists of the following:

1. The variation in dust and gas concentration which may develop, and its significance to the number of required samples.

2. The significance of particle size to dust retention in the lung.

3. The size distribution that one encounters in mine dust.

4. The significance of mean average concentration and time-weighted average dust concentrations.

5. The effect of methane concentration or explosibility of coal dust and the role of particle size to this hazard.

6. The instrumentation available and the pitfalls in their use.

I would like to discuss these points in the time remaining for my presentation.

Variability in Dust Concentration

I have not experienced, in my years of experience in dust assessment, as great a range of airborne dust concentrations as that which can develop in coal mining at the working face. The role of the mining machine operator is considerable, for he can create must dust, regardless of well-applied control measures, by his operating practice. This large variation in dust at the working face is also found in Great Britain. In a recent paper [6] by members of the National Coal Board technical staff, a ratio of 270:1 is reported in the range of dust concentrations. They indicate that in English mines, high airborne concentrations result from (a) cutting in dirt, either roof, floor or midseam bands, (b) slow advance of the machine, giving a scraping rather than a cutting action of the picks and (c) high pick speeds, increasing the airborne dispersion of the dust.

The cause of appreciable variations in airborne dust at the working face is readily understood by anyone who has undertaken assessment of dust at the working face. The operation of mining equipment is periodic during a shift, due to awaiting another shuttle car, tramming into position, downtime for extending or repairing the brattice or curtain and breakdowns, and differences in each operator's operating practices. In addition, the volume of the working space from the face to the CMO is about 1300 cubic feet. The equipment itself occupies about 50-60% of this space. In this relatively limited space, appreciable dust is generated, high velocity water sprays are present, and ventilating air currents sweep along the working face. Under such conditions, turbulence and eddying of the air currents can develop, and variability in the concentration of the airborne dust is normally experienced.

We have found wide variations but not to such a wide degree. However, due to this factor, a large number of samples is necessary in order to obtain representative measurements of dust concentrations.

In our work, we have set 70 samples collected in the breathing zone of the CM Operator during 6 days, over a two-week period, as our objective, as the minimum number of samples and period of sampling, for respiratory hazard evaluation. In the survey to evaluate control measures or in our study of the effect of the major operating variables to dust production, we have found 40 samples, collected on four days over a two-week period, are adequate.

Dust Retention in Lungs

Airborne industrial dust includes a considerable portion, by weight, of particles which are too large to be of interest in the causation of pneumoconiosis. The size consist of inhaled dust determines its approximate site of deposition in the lungs. Therefore, one can consider the lungs as an elutriator which separates the inhaled dust into two major fractions of which one is trapped in the nose, trachea and other portions of the upper respiratory tract, while the other is deposited deep in the pulmonary air spaces. The health hazard due to the deposition of mineral dust in the respiratory system does not necessarily depend upon the number of particles trapped, but in the case of pneumoconiosis, the risk depends upon the site of deposition. Pneumoconiosis develops as a result of excessive deposition in the minute pulmonary air spaces. Therefore, in the instance of this disease, the separation of dust from the inhaled air by the upper respiratory system serves as protection against the disease rather than an increased risk.

Many researchers have studied the mechanism of pulmonary deposition of dust and the general conclusions have been well validated. Brown, et al, [7] demonstrated that particle retention decreases with particle size from nearly 100% for particles greater than 5 microns down to about 25% for particles 0.25 microns. A lower retention occurs with mouth breathing than with nasal breathing. Nasal retention likewise decreases with the size of the particles from about 100% for the size range of 5-10 microns to zero for particles of about 1 micron. From the point of view of pneumoconiosis risk, only those particles that are trapped in the terminal air spaces of the lower respiratory system are of concern. These spaces have high retention efficiencies for the particles between 1 to 5 microns and, therefore, the efficiency of our sampling instrument must be high in this size range and analytical procedures for our health hazard evaluation are based upon this range of particle size.

In the United States, we report dust concentrations on a particle count basis rather than on the mass concentration or surface area basis. This is due to a number of reasons. First, a few large particles, if

included in the sample would greatly distort the determination, and such particles have no relation to the pneumoconiosis risk. Second, our standards of permissible dust levels have all been developed by correlation of count with medical findings.

Finally, our present practice of reporting on a particle count basis is principally due to the work of Greenburg and Bloomfield and their associates in the U. S. Public Health Service. Their studies of the dusty trades, [8,9] upon which the permissible dust levels were established, reported dust concentrations in terms of the number of particles rather than by weight. They indicated how misleading weight concentrations could be since one 10 micron particle, for example, contributes as much weight to a sample as 1000 particles of 1 micron size.

Size Distribution of Coal Dust

As mentioned early in this paper, the evaluation on the health hazard risk is based upon particle count, but the explosion hazard risk is evaluated on a weight basis. Therefore, both types of determination are essential.

Coal dust from mining operations is exceedingly small in size. The size distribution of such dust has been reported by a number of investigators. The advent of continuous mining equipment does not appear to have materially altered the percentage of fine particles ($<5\ \mu$). However, this is merely an observation based upon conventional mining done in the period 1936-1941, and there is a need for considerably more investigation of the size spectrum of dust, not only in the coal industry, but as an important need generally for all dusts. The two major studies [10,11] of coal mining in this country were done in the 1936-1941 period. They report on the size distribution of dust in bituminous and anthracite mining. The bituminous coal study, done in 1941 in Utah, reported that 83% of the dust was less than 5 microns with a median size of 1.94 microns. Figure-1 reveals the size distribution of the airborne dust. The anthracite study, done in Pennsylvania in 1936, reported that practically all the particles were under 4 microns, with 80% between 0.5 and 1.5 microns. The Medical Research Council of Great Britain in their 1943 report, previously referred to, reveals a similarly high percentage of small particles.

In our studies of size distribution of particles at the working face, the predominance of particles under 5 microns was likewise demonstrated. We have compiled in Table-2 pertinent data from all these mentioned studies. It is this data which led me to note previously, as a preliminary observation, that continuous mining with a boring type machine does not appear to have increased the fineness of the dust as compared with earlier methods.

The significance of particle size is a different matter when equating the explosion hazard potential, for, while the vast majority of airborne particles are small, they contribute little to the total weight of the dust. For example, in the study [3] by Bituminous Coal Research, Inc., previously mentioned, practically all the weight of the dust was due to particles above 5 microns, as shown in Figure-2. These results were obtained from dust settling on trays located in the returns. We have found a slightly higher percentage of the <5 micron particles to the total weight of the airborne dust at the face. The majority of small particles of health hazard potential would be swept out of the mine in the ventilating current. The weight of the small dust particles which is of pneumoconiosis consideration is a very small fraction of the total weight of the airborne dust.

The lower explosive limit of coal dust is 0.05 oz/c.f. of air. If we assume spherical particles, this is equivalent to 1,961 million (1.9×10^9) 10-micron particles per cubic foot of air or 1.9×10^{12} of 1-micron particles. The Bureau of Mines standard is 2.0×10^7 particles per cu. ft. of air, for equating health hazard potential. Hartman [12] reported that the size, shape and surface structure of dust particles influence their explosive characteristics and experiments have shown that, when finely divided dust is present, particles of coal as large as 800 microns contribute to the explosion. He stated that, in general, the explosibility of dusts increase with a decrease in particle size, because finely divided dust has a higher specific surface which results in a greater volume of oxygen absorbed per unit weight of dust. On the other hand, he also

stated that in a few instances, it was observed that the very finest coal dusts are less reactive than somewhat coarser dust. It would appear that more research is necessary to determine the relationship of particle size to explosibility and that the dust concentrations which we have obtained and seen reported in the literature are well below the lower explosive limit by a very large factor of safety. However, a word of caution, dust concentration data is based on samples beside the CMO or, as we have also done, beside the machine just behind the trim chain of a boring type machine. There is great need, in our opinion, to develop methods of reliably sampling air much closer to the face.

Exposure vs. Concentration

Exposure to mineral dust of pneumoconiosis interest must be expressed as a time-weighted average exposure, which is based on air samples collected during each phase of the miner's work procedure and average time spent in each phase. The dust concentration determined from counting air samples is a means for calculating the exposure but is not an index of the potential health hazard. As previously mentioned, the permissible levels used in the United States specify that they represent "time-weighted" average exposures. Such an exposure is calculated from the following formula:

$$\text{Time-Weighted Exposure} = \frac{E_1T_1 + E_2T_2 + E_3T_3 \ldots E_nT_n}{\text{Daily Hours of Work}}$$

E_1 = Mean average dust concentration during each phase of the job procedure.

T_1 = Time spent in each step of the job.

The U. S. Bureau of Mines, indicates that its "standard" of 20 million particles per cubic foot of air is on a time-weighted average basis by the words "average full-shift concentration".

There are several procedures for obtaining this measurement. As far as we are concerned, we turn to our time study engineers for a breakdown of the steps in each job classification, and for the percentage of full shift time assigned to these steps. Next, we proceed to collect the number of air samples during each step and over several days as mentioned earlier in this paper. However, as the major dust generation and variation in dust concentration is produced at the face, the largest number of air samples is obtained in the breathing zone of the continuous mining machine operator (CMO). Experience also has shown that very low dust concentrations and little variation occur in such steps as the man-trips, lunch time, breakdown periods and other steps during which the machine is not operating. Therefore, some of these steps can be grouped together. The following example serves merely to demonstrate the method of calculating the exposure of a CMO.

	Time %	Average Dust Concentration (mppcf)
1. Mining and Maneuvering	58.5	38.5
2. Breakdown, Idle Time & Place Change	20.5	6.5
3. Misc. (timbering, bit changing, etc.)	3.0	4.3
4. Lunch	6.0	3.5
5. Man-trip	11.0	4.5

Let us then assume that our dust measurements in each step indicated the mean average values as shown. The time-weighted concentration (TWAC) over the full shift can be calculated as follows:

$$T.W.A.C. = \frac{(58.5x38.5) + (20.5x6.5) + (3.0x4.3) + (6.0x3.5) + (11x4.5)}{8}$$

$$= \frac{2470}{8} = 30.9 \text{ mppcf}$$

The major pitfall here is in not obtaining a sufficiently large number of air samples at the mining machine operator and over several days in order to cover all operating conditions.

Another method in use is to obtain a five-minute air sample every 15 minutes while following the operator about, throughout the full shift. Similarly, each man in the different job categories would be followed about to obtain dust measurements. It is necessary to spend more time with the CMO, SCO and Brattice Man than in other jobs for these are the jobs in which the major variations of dust concentrations may be expected in continuous mining operations.

Methane vs. Dust

We have stated that in evaluating dust concentrations in coal mines, one must give consideration not only to the role of dust to pneumoconiosis but also to the explosion potential. It has been shown that in the assessment of dust in relation to the former respiratory condition, our interest is limited to particles in the range of 1-5 microns. In the case of explosibility of the dust in gaseous mines, no such limits of particle size is apparently involved. In gaseous mines, the lower explosive limit of coal dust varies inversely with the methane concentration, [13] as shown in Figure-3.

The effect of particle size on explosibility of coal dust is an area of investigation requiring more intensive study, due to present rates of coal extraction with continuous mining equipment and the influence of gas to this potential hazard. Our present knowledge on the explosibility of dusts, particularly of coal, is principally due to the many scientific contributions of the U.S. Bureau of Mines. A fairly recent report [14] states that the effect of particle diameter on the minimum explosive concentration is pronounced for dusts coarser than through a No. 200 sieve ($>70\,\mu$), but is negligible for finer dust. It further states that explosibility varies inversely with the cube of the particle diameter, for dust having a normal particle size frequency distribution curve. For dust having a discrete size ($149\mu - 210\mu$), the increase in explosibility with decrease in particle diameter is said to be more marked. This size range is considerably above the range of health hazard potential. Based upon this data, it is our personal view that among the major voids in our knowledge is the relationship of dust concentration to explosibility in various size ranges of particles, particularly in the range under 10μ. In speaking of the lower explosive limit of coal dust (.05 oz/c.f.), it would appear of major interest to have more information on the effect of methane concentration to this limit, for the size range of dust of pneumoconiosis significance.

Sampling Instruments

The instruments and subsequent procedures now used throughout the world provide only an approximation of the dust concentration. It is by no means a science of great refinement when used in the field. Therefore, the operator must be one of sufficient skill, or supervised by one with such professional training.

Sampling instruments for assessing airborne dust have been under intensive investigation for several years. This work is motivated by many factors, among which are the very tedious and time-consuming procedures of our standard practice, the human errors in counting and sizing particles and the need for size-selective sampling instruments throughout the full range of the dust in the air, but particularly in the $1\text{-}5\mu$ range. The instrumentation requirements are far more demanding for pneumoconiosis evaluation than sampling for evaluating engineering control or explosion risk. Therefore, my comments will relate to instrumentation for determining the pneumoconiosis risk. The ideal instrument would be one which would collect

the dust from the air and separate it in various size fractions without altering the physical parameters of dust, and which would allow fairly rapid particle counts in the field. No such instrument exists, but from the investigations underway, considerable improvement over present methods may be expected in the not too distant future. However, there are major points that must remain uppermost in the minds of all investigators in the United States which we mentioned early in this paper, but should be emphasized. First, the aerosol particulates which we are seeking, and the form with which the data is obtained, must be of, and allow, biological interpretation. In other words, our only interest is in the particles which may result in pulmonary disability.

Second, any instrument will produce results only as good as the experience of the user and the diligence with which he applies his knowledge.

Third, our standards are based upon air sampling with an instrument, the impinger, that was used in establishing the biological standard of maximum permissible dust concentrations. Therefore, any new instrument must correlate with the impinger data. It is for this reason, that we do not believe the impinger, with its subsequent visual counting and sizing procedures, will be completely superseded. It will be necessary to use this instrument as the standard for calibrating any new instrument, if and when they have been proven acceptable. In view of this situation, what is necessary in my opinion, is a reacceptance of the use of the impinger to the degree of applying the same diligence, care and scientific interest to its use, and its subsequent analytical procedures, that was applied by the early workers in the U. S. Public Health Service and the U. S. Bureau of Mines.

Many research workers have been endeavoring over the years to develop instrumentation which in their opinion accomplished the objectives above mentioned. Such sampling instruments have been developed and work is continuing in the United States, England, South Africa, Germany and other countries. The operation of the most promising are based upon the application of the principles of settlement, filtration, water scrubbing, impingement and light scattering (photometric). A brief review of the major ones now in use should be appropriate.

The impinger is the American standard. It is shown in Figures 4, 5, and 6. It is the so-called midget impinger, since it is a smaller model of the original and more cumbersome instrument. It is manually operated by a hand pump as seen in Figure-4. A more detailed view of the pump and case, containing nine impingers (glass tubes), is shown in Figure-5. It may also be operated by an injector utilizing pressurized air or freon gas, such as shown in Figure-6. The entire unit weighs less than 2 lbs. This is particularly applicable to potentially explosive atmosphere. The midget impinger samples the air at the rate of 0.1 cfm (2.83 liters/min) with a resistance across the nozzle of 12 inches of water. The instrument has high collection efficiency of particles down to 1-micron. Its low collection efficiency for particles under this size is not important for our standard of permissible dust levels are based upon particles of 1-5 microns. Air is drawn through a nozzle, the end of which is immersed in filtered water or alcohol. The dust is wetted, by means of high velocity impingement, on the bottom of the flask and is retained in the liquid. A small portion of the liquid is placed in a cell and the particles are counted by means of a microscope. It does break up airborne agglomerates and may shatter particles with the result that the counts may be high in some cases.

The Thermal Precipitator is the standard instrument used in Great Britain since 1948. One type of this instrument, which is marketed in this country, is shown in Figure-7. The sampling head, which is the small cube-like element on the top, is shown in more detail in Figure-8. The instrument consists of a heated wire mounted between the microscopic slides on which the dust particles are deposited in a strip about 1-millimeter wide. The slides are placed under a microscope for particle counting and sizing. The deposition is accomplished by the principle of a thermal force, induced by the heated wire, repelling the particles in the air to the glass slide. In one widely used design, air is sampled at the rate of about 7 cubic centimeters/min., as compared to the midget impinger sampling rate of 2830 cubic centimeter/min. However, several variations in the design are available. A larger model is also in use, which allows a single integrating sample over a full shift. It is designed to operate unattended at a fixed location in a coal mine, as for example, in the returns or close to the face. Air is sampled, in the continuous sampling instrument, at a rate of 2 cubic centimeters per minute. The thermal precipitator is stated to be the most efficient instrument for collecting dust from 5 microns down to 0.01 microns, without altering its physical

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Figures 4 through 14 have been omitted due to technical difficulties with reproduction. Their deletion is with the consent of the author.

parameters. However, despite certain advantages, the instrument has several disadvantages. There is an overlapping of particles which can result in particle counts lower than actual concentrations. Its high collection efficiency for particles below 1-micron have limited, if any, value. In practice, it has been stated that the dust does not deposit uniformly on the glass slides. In laboratory studies, the chief errors are those of particle counting and sizing, but the conditions encountered in coal mines can introduce instrumental errors greater than the counting errors. It is probably these difficulties that has resulted in intensive studies by the National Coal Board, and the Safety in Mines Research Establishment scientists on gravimetric methods of dust assessment.

Another instrument, widely used for dust assessment in Canada and Germany is the Tyndalloscope. In the German coal mines, dust concentrations are determined by this instrument, one of the improved types is shown in Figure-9. The operating principle is based upon the determination of the intensity of scattered light caused by the dust particles suspended in the air in the closed dust chamber of the instrument. The degree of light scattering, created when a beam of light is directed through the chamber is in an established relationship to the concentration of dust. The measurement requires 20 seconds, according to the manufacturer, after the dust chamber is closed. This time interval, before making a reading, is necessary in order to allow the large dust particles to settle. The instrument is battery operated. The dust chamber (7) is open on both sides to allow passage of the dust-laden air while its other walls are lined with black glass plates. The instrument consists of a dust chamber (7), an illuminating arrangement (4), a light-dimming unit and an observation eye piece (1). In actual operation, the dust chamber cover (7a) is closed after the air is allowed to enter the chamber. The built-in illuminating arrangement is operated by pressing a knob (10), part of the light which is directed into the chamber, is deflected on the dust particles, while the remaining direct light will be eliminated by reflection and absorption. Half of the observation eye piece is illuminated by the scattered light from the particles and the other half, which is the measuring field, can be equally illuminated by a light-dimming arrangement, consisting of two polarized filters. After both halves have been equally illuminated, the angle through which the knob (4) is turned, is read by a magnified and illuminated scale. This reading is applied to a nomograph or tables, and the dust concentration determined. The instrument is most convenient to use as it weighs only about 4-1/5 lbs, and provides readings quite rapidly. However, like all light scattering or photometric instruments, it will be influenced by all particulates – smoke, oil droplets and water droplets – and, therefore, can overestimate the dust concentration. In addition, it samples a small volume of air.

The Konimeter was one of the earliest instruments developed. Its first use was in South Africa for assessing dust in gold mines. The earlier model is shown in Figure-10. The presently available German instrument, known as the Sartorius Konimeter – HS is shown in Figure-11. German mines are surveyed officially and the work conditions graded by the use of the Tyndalloscope and Konimeter, in addition to a filtering device for measuring the total amount of dust, the ash content and the quartz in the 1-5 micron dust. [15] Both instruments are widely used in Canada, as well as Germany. These instruments sample air at the rate of 2.5 or 5 cubic centimeters. The dust in the air impinges on a section of a vaseline coated circular glass plate which has sections for 36 samples. An attached microscope allows immediate counting. One model is used where the airborne dust concentration is <5000 particles per cubic centimeter (141.5 mppcf). The mining model (Fig. 11) is for dust assessment, where the dust exceeds this concentration, and contains a sedimentation bell which is supposed to separate out the particles >5 microns. A sampling time per sample of 30-60 seconds is recommended. The manufacturer's literature states that 8-13 samples should be a minimum number when the dust concentration is constant and 15-25, or more, where dust conditions vary. The efficiency is stated to be ± 12% and particles under 0.8 microns can be counted with special attachments. When considering the large variation in dust concentrations in coal mines, the number of samples that would be necessary, the efficiency of the instrument, and the very small volume of the air sample, we would have a number of reservations on its use.

Considerable development of instrumentation has been continuing in Great Britain for many years. Intensive work to develop a gravimetric instrument which collects the respirable fraction of the dust and which appears to have promise as the standard measuring device to replace the thermal precipitator is the Conicycle. British authorities are of the view that gravimetric sampling for routine dust control is preferable to other measures. The claim for this instrument is that it will run continuously throughout a shift and collect sufficient dust in the respirable size range to allow a weight determination as well as a

chemical or mineralogical analysis. 16/ It is portable, automatic and practical for mine use. A cross section of the sampling head is shown in Figure - 12 and its calculated performance curve is shown in Figure - 13. Power is provided by nickel-cadmium batteries which are rechargeable. The instrument weighs 19 lbs. The sampling head is rotated about axis Z (Figure 11) at 8000 rpm. Its calculated performance curve indicates dust collection which confirms very good with human pulmonary retention curves.

Another British instrument, which is a high volume sampler, is the Hexhlet. It is a two-stage sampler. The major details are shown in Figure 14. It is operated by compressed air. The first stage is a gravity elutriator, which consists of two banks of horizontal plates (A) separated by a vertical partition. This design results in 120 ducts. Beyond the elutriator is a critical orifice (B), which opens into the second stage, a filter (D). The instrument samples air at the rate of 100 liters/min. (3.5 cfm) and, over 8 hours of operation in a coal mine, will collect about 1 gram of respirable dust when the airborne concentration is about 24 million particles per cubic foot of air. There is the problem of re-entrainment of settled dust with this device. However, a modified instrument is available which operates at 50 liters/min. (1.8 cfm), with a smaller number of plates, to correct this problem. It is claimed that the instrument excludes particles larger than 7 microns. The sample of respirable dust is collected in the thimble filter and it can be weighed or a silica analysis undertaken. The critical orifice will maintain the correct flow rate when the air gauge pressure is above about 4 inches Hg. This smaller model weighs 11 ½ lbs.

Selection of Instruments

It is quite evident that the British scientists at the National Coal Board and the Safety in Mines Research Establishment have been most active in the development of instrumentation. Their present apparent emphasis on the Conicycle does appear that they are moving toward a gravimetric standard rather than a particle count standard as we use in this country. It is possible to correlate the weight of airborne dust with the particle count, but this must be done for each major dust producing operation when the size distribution and type of dust varies. The recognition in Great Britain of the need for a relatively simple instrument to eliminate much of the time-consuming procedures now in use, in both England and the United States, is well recognized by all of us as a major requirement. Even with their very large staff of dust assessors, they cannot accomplish, apparently, the amount and degree of investigations required. We must not overlook in this country that we have a standard based upon a count basis and use a fairly fixed practice. However, this should not preclude our evaluating their instruments, as well as any others which show promise of accuracy, reproducibility and correlation with the impinger technic. As a matter of fact, we must undertake this work, for we have too long abstained from such efforts, while we complain about the time involved and our needs for improved measurement technics.

One should also recognize that none of the instruments provide particle count and a sufficient quantity of respirable dust for weight determination and chemical or mineralogical analysis. Therefore, in dust assessment work, there is no complete instrument and at least two instruments are necessary to obtain adequate data for evaluation. In selecting an instrument for field use, one must determine the purpose for sampling, such as pneumoconiosis evaluation, determination of composition, explosion potential, etc. We in this country must continue to utilize the impinger at present for particle counting. Our major voids, in my opinion, in our dust assessing instrumentation is the need for obtaining a sufficient sample of the respirable dust for free silica determination, and for determining the size spectrum and particle count in a short period of time.

The selection of an instrument for evaluating the explosion hazard potential would appear to require merely a high volume sampler of some type, since our objective is a weight determination. However, since this potential hazard is said to vary inversely with the cube of particle diameter, some estimation of size fractions would be desirable. However, what is urgently needed in coal mine studies is some instrument which will allow at least a weight determination well in by the continuous mining machine operator, where maximum dust and gas may exist.

When we are concerned only with the degree of dust control achieved by dust control ventilation or some improved practice, our instrument needs are considerably less demanding for such "before and after"

determinations. An instrument, which provides only a weight determination, may be quite adequate. In addition, the Tyndalloscope or Konimeter may also be adequate for this purpose since it will provide an estimated count which can be obtained prior to and after the installation of the control measure. However, with such small volume samplers, a large number of air samples should be taken. However, in both cases, the user needs to have adequate experience in this use and should satisfy himself that he is counting mineral particulates.

Analytical Procedures

In the use of the impinger and its subsequent counting and analytical procedures, more errors arise in the collection of the sample. Unless one has had a great deal of particle counting experience and performs this work frequently, there is often a significant error. One is not adept in these procedures, whether or not he is professionally trained, unless he is trained in, and has been applying the method for some time.

Deviations have occurred over the years from the U. S. Public Health Service procedure originally developed. There have involved the collecting fluid, settling times, source of illumination, and the interval before counting after collection. There is a real need, in my opinion, to review this procedure and to develop correction factors where necessary or to establish an improved procedure. Today, it is our opinion, based upon more than observation, that the dust count derived by different laboratories have too large a variance, and we are urgently in need for real standardization with a detailed procedure.

Conclusions

We have attempted to discuss with you the problems involved in an accurate appraisal of airborne dust in coal mines. It is a problem which, in our opinion, is not simple and involves an application of instrument and subsequent analytical procedures, which, if not applied diligently by one with experience in dust assessment work, can lead to appreciable error. The permissible levels of airborne dust established in this country are similar to those used in Great Britain. Attention is directed to the fact that these levels are based only on that respirable portion which is of a particle size that can be deposited in the small pulmonary air spaces. This is dust in the size range of 1-5 u. Attention has also been called to the fact that these levels are based upon a time-weight average concentration over a full working shift and that to obtain adequate data, a large number of samples must be obtained at the working face, due to the very significant variations in dust concentrations normally encountered.

There is considerable research underway chiefly in Great Britain, but also in this country, to develop sampling devices which will greatly reduce the time-consuming laborious procedures used in the American practice. However, until such time that such instruments produce data comparable to that obtained by use of our standard instrument, the Impinger, our assessment technics must continue as in the past. Finally, while the assessment of dust of interest to this Conference is limited to the pneumoconiosis risk, any such assessment must consider the explosion risk, despite the fact that the airborne dust concentration, in the respirable range of particle size, are well below the minimum explosive concentration for coal dust.

REFERENCES

1. Silicosis in the Metal Mining Industry – A Revaluation (1958-61) – Public Health Service Publication No. 1076, U. S. Superintendent of Documents, Washington, D. C.

2. Nagelschmidt, G., The Study of Lung Dust in Pneumoconiosis – Annual Meeting – American Industrial Hygiene Association, Philadelphia, May 1964.

3. Saltsman, R. D. – Recent Developments in Coal Dust Control, Annual Convention – Mine Inspectors Institute of America, Richmond, Virginia, June 15, 1964.

4. Westfield, J., Anderson, F. G. – Roof Bolting and Dust Control, I.C. 7615, 1951, U. S. Bureau of Mines.

5. Fay, J. W. J., and Tomlinson, R. C., The Measurement of Airborne Dust in British Coal Mines, Geologie en Mijrbonw (NW. Ser.), 21e Jaargang, September 1959.

6. Cuckow, R. W. and Walton, W. H., Environmental Problems Raised by the Rapid Advance of Coal Faces, Colliery Guardian, March 20, 1964.

7. Brown, J. H., Cook, K. M., Ney, F. G., and Hatch, T. F., Influence of Particle Size upon the Retention of Particulate Matter in the Human Lung, Am. Journal of Public Health, 40:450, 1950.

8. Russell, A. E., Britten, R. H., Thompson, L. R., and Bloomfield, J. – The Health of Workers in Dusty Trades II Explosure to Siliceous Dust, Public Health Service Bulletin, No. 187, 1929.

9. Greenburg, L. and Smith, G. W. A New Instrument for Sampling Aerial Dust, U. S. Bureau of Mines, R.I. No. 2392, 1929.

10. Soft Coal Miners Health and Working Environment – U. S. Public Health Service, Public Health Bulletin, 270, 1941.

11. Anthraco-Silicosis Among Hard Coal Miners, U. S. Public Health Service, Public Health Bulletin 221, 1936.

12. Hartman, I., Dust Explosions in Coal Mines, The Scientific Monthly, August, 1954.

13. Nagy, J. and Portman, W. M., Explosibility of Coal Dust in an Atmosphere Containing a Low Percentage of Methane, R. I. 5815, U. S. Bureau of Mines, 1961.

14. Jacobson, M., Nagy, J., Cooper, A. R. and Ball, F. J., Explosibility of Agricultural Dusts, R. I. 5753, U. S. Bureau of Mines, 1961.

15. Bruer, H., Inhaled Particles and Vapors, edited by C. N. Davies, Pergaman Press, New York, 1961, pp. 453-460.

16. Caver, J., Nagelschmidt, G., et al, The Conicycle, A Portable Gravimetric Airborne Dust Sampling Instrument and Its Preliminary Calibration Against the Long-Running Thermal Precipitator, Mining Engineer, No. 21, June 1962.

TABLE 1

BRITISH COAL MINES
PERMISSIBLE STANDARDS OF DUSTINESS

Type of Mine	Permissible Dust Concentrations		British Standard Expressed in U. S. Units (mppcf)	USBM Standard (mppcf)
	Particles per cubic centimeter of air	Size Range (microns)		
Anthracite	650	1-5	18.4	
Non-Anthracite	850	1-5	24.0	20
Stone Drifts and Hard Headings (all mines)	450	1-5	12.7	

In British practice, dust concentrations in coal mines are reported in terms of numbers of particles 1-5 microns (μ) in size per unit air volume, as determined from Thermal precipitator samples. Particles coarser than 5μ are rejected from the hygenic evaluation.

TABLE 2

PARTICLE SIZE DISTRIBUTION

Study	Total Percentage of Particles below Stated Size				Medium Size (μ)
	0.5 μ	1.5 μ	4.0 μ	5.0 μ	
USPH Anthracite Survey -- Penna., 1934	8.0	88.0	99	99	0.9
USPHS Bituminous Survey -- Utah, 1941	2.8	40.3	71.8	96	1.94
USS - CM Mining (Augur Type)		1 μ	4 μ	5 μ	
-- Penna., 1963		39.1	84.8	88.7	
Great Britain - South Wales	0.4 μ	1.2 μ	4 μ	5 μ	
1943					
Longwall Stalls	27.3	60.5	89.6	94.3	
Narrow Workings	27.8	66.6	93.1	97.0	

FIGURE 1

SOFT COAL MINERS' HEALTH AND WORKING ENVIRONMENT, USPHS, BULLETIN 270, 1941

Particle-size Distribution of Coal Mine Dusts.

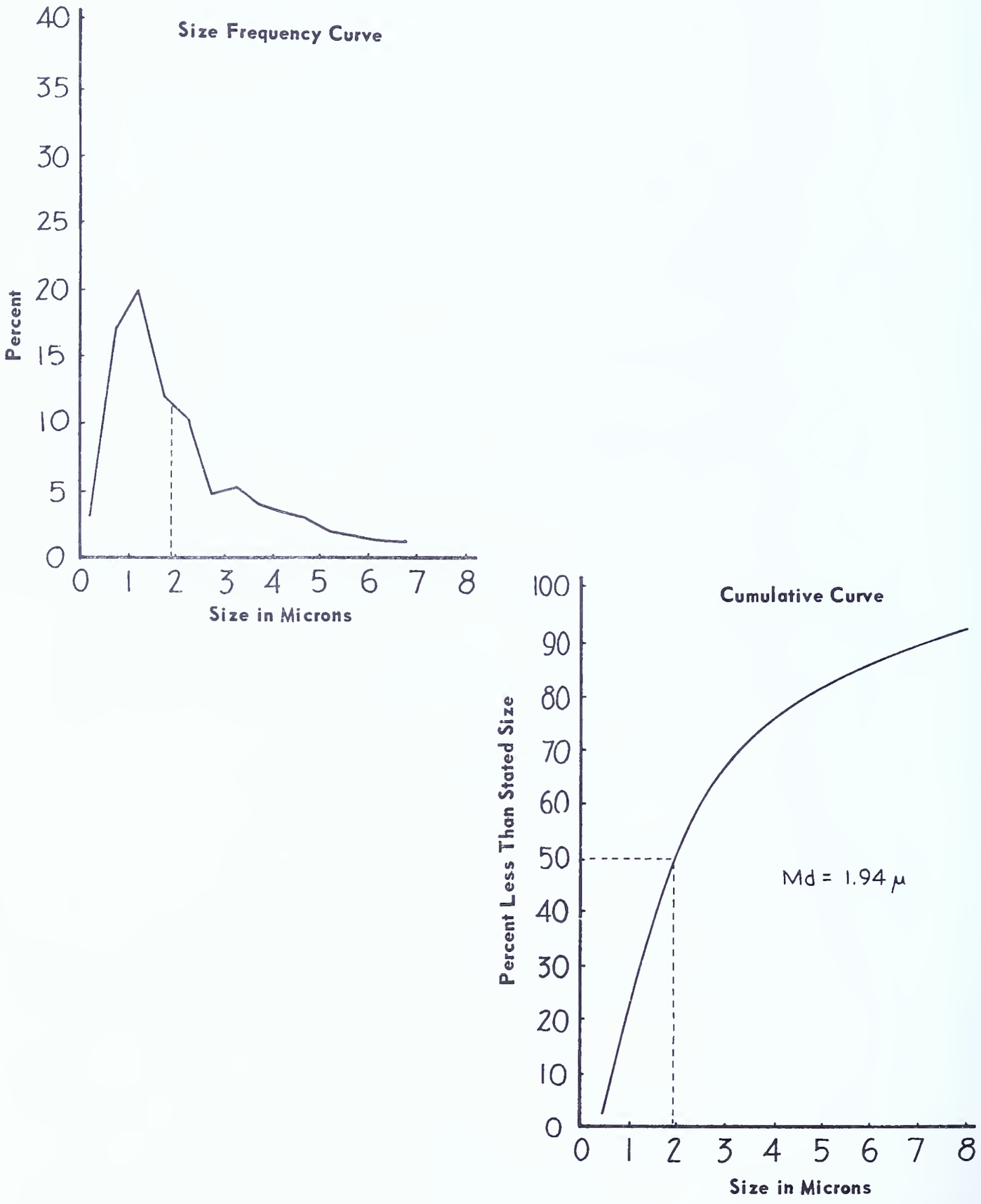
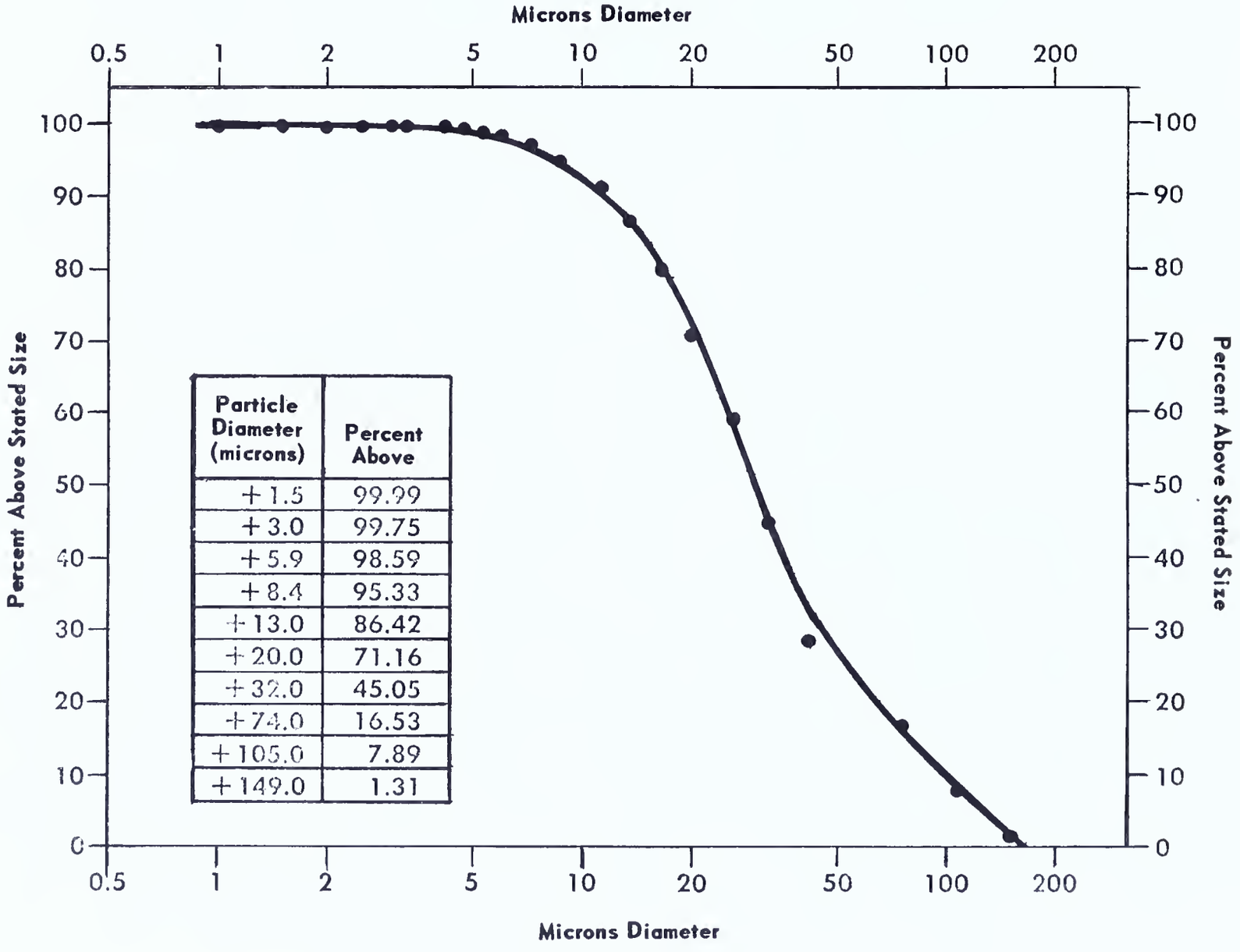


FIGURE 2

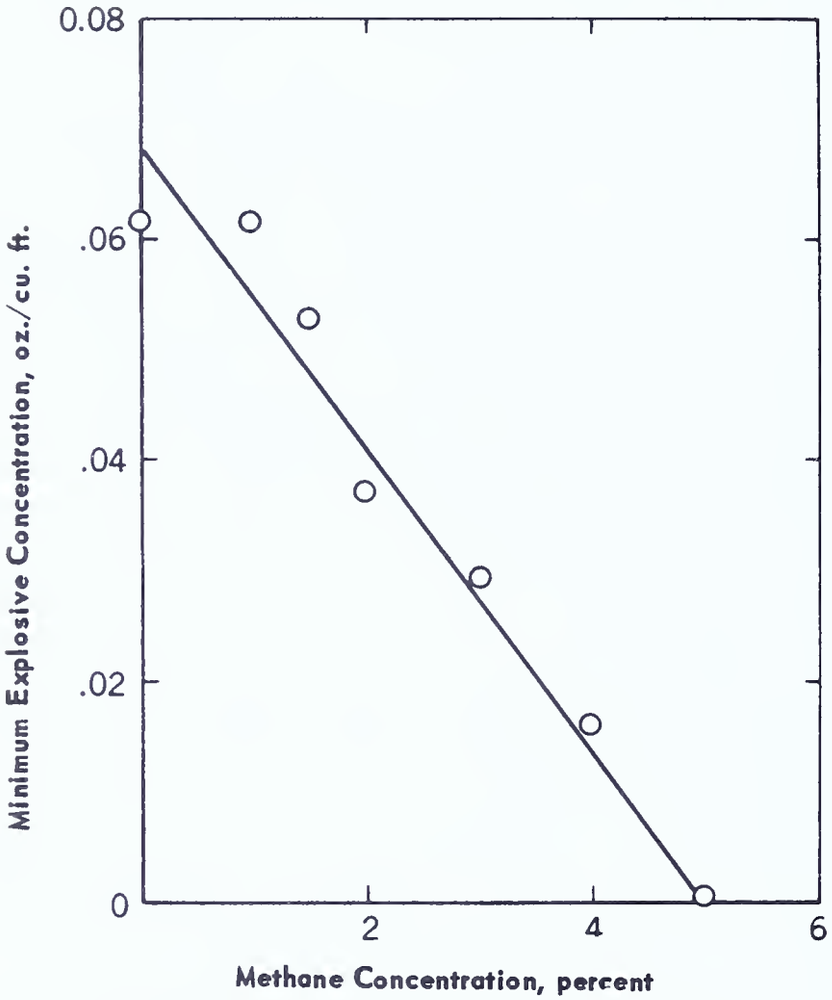
SIZE DISTRIBUTION OF AIRBORNE DUST IN A MINE



Particle Diameter (microns)	Percent Above
+1.5	99.99
+3.0	99.75
+5.9	98.59
+8.4	95.33
+13.0	86.42
+20.0	71.16
+32.0	45.05
+74.0	16.53
+105.0	7.89
+149.0	1.31

FIGURE 3

INFLUENCE OF METHANE CONCENTRATION ON LOWER EXPLOSIVE LIMIT OF COAL



Minimum Explosive Concentration of Coal Dust in Methane-Air Atmospheres (0.043-cu.-ft. Chamber). USBM–RI 5815, 1961

METHODS OF DUST CONTROL USED IN THE BITUMINOUS COAL MINES OF PENNSYLVANIA

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Early History

If one could assemble annual photographs of the faces of miners coming out of the mine at the end of the shift, from the late 20's to date, the progress of atmospheric dust control underground would be evident.

In the hand loading days of the twenties and the early mechanical loading days of the thirties, men came out of the mine with faces caked with black coal dust. Today, faces are relatively clean.

In the early days, spraying water to alleviate coal dust suspension in the air was rare. The velocity and quantity of air at the working face was normally just sufficient to comply with the law, that is 150 to 200 c.f.m. per man. The use of line curtains or brattice cloth to conduct air to the working face of the hand loader was dictated more by gas emission than by dusty atmosphere.

During the time the face was being undercut without the use of spray water, dust counts ranging from 96 to 227 millions of particle per cu.ft. of air have been observed and during the hand loading of the cut, counts of 38 to 268 m.p.p.c.f. were obtained.

Mechanical Loading

The advent of loading coal by machine in the late thirties and its phenomenal growth during the forties and early fifties brought changes.

First, in order to operate efficiently, it was necessary to increase air quantities at the face, primarily to dilute and carry away methane which was being liberated in increasing quantities by the more rapid rate of penetration brought about by increasing coal production through loading mechanically. Increasing air flow had a tendency to reduce dust concentration at the face by carrying it away from the face and into the return airways, particularly when line curtains were installed, a practice which became increasingly prevalent. Second, to improve visibility at the face for mechanical loading operations, water was sprayed on the cutter bar of the cutting machine in order to wet the fine coal or "bug dust" produced by the cutting operation. After the cut was blasted or shot, water was sprayed on the broken coal being loaded out by use of sprays on the loading machine or by spraying the broken cut with a water hose just prior to loading it out with the machine.

During this period dust counts of 40 - 50 m.p.p.c.f. were observed during the cutting operation while the counts observed during the loading by machine were of the order of 10 m.p.p.c.f.

In 1946, the "Federal Mine Safety Code", as provided by agreement between the Coal Mines Administrator and the United Mine Workers of America, became effective. Specific provisions dealing with atmospheric conditions underground were as follows:

Article VI, Section 1,b: "Where mining operations raise an excessive amount of dust into the air, water or water with a wetting agent added to it, or other effective methods shall be used to allay such dust at its source."

Article IX, Section 1,b: "Rock drilling with percussion drills shall be done wet except as provided in Article XI, Section 7g."

Article XI, Section 7g: "Men exposed for short periods to gas, dust, fume, and mist inhalation hazards shall wear permissible respiratory equipment. When the exposure is for prolonged periods, other measures to protect workmen or to reduce the hazard shall be taken."

The Bituminous Mining Law of Pennsylvania, Article II-H, Section 251 requires that coal dust and other dust in suspension in unusual quantities shall be allayed by sprinkling or other dust allaying or collecting devices.

Under these regulations, the use of spray water to control dust during mining operations at the face became widely accepted and mines began to be equipped with piped water systems to conduct spray water to the face areas and for fire portection.

About the same time, in the early fifties, roof bolting became prevalent and, under Article XI, Section 7g of the Federal Code, drills for drilling holes in the roof in which roof bolts were installed were required to be equipped with approved dust collecting devices.

The progress in dust control in Pennsylvania Mines during this period is illustrated by statistics published by the United States Bureau of Mines in I.C. 7566 entitled "Review of Dust Allaying Practices at Working Faces in some Bituminous Coal and Lignite Mines - 1950". The data for this report was collected by Federal Coal Mine Inspectors in 1637 mines in the United States of America, 293 of which were in Pennsylvania. Compared with national averages of those mines in which dust control was deemed necessary, the percentages of mines in which dust control was actually practiced were as follows:

	Average in U. S. A.	Average in Pennsylvania
Hand Loading	23%	58%
Mechanical Loading	58%	86%
Combination of Hand and Mechanical Loading	42%	69%

Continuous Mining

In the early fifties the continuous mining machine was introduced, and its use rapidly multiplied until, in the early sixties, over 50% of the underground production in Pennsylvania came from continuous mining machines. These machines eliminated the cyclic functions of cutting, drilling, blasting, and loading by breaking the coal directly from the face without the use of explosives and loading the coal directly into transportation vehicles or depositing the broken coal on the floor where it was picked up by loading machines and delivered to transportation vehicles such as mine cars, shuttle cars, or conveyors.

High pressure water sprays are standard equipment on all continuous miners and are used to allay dust as the coal is being broken from the face. Usually the coal is sufficiently wetted by the sprays on the machine that very little additional spraying at transfer points behind the continuous mining machine is necessary for atmospheric dust control purposes. Where necessary, additional sprays are used at transfer points such as shuttle cars to mine cars or belts and when belts discharge coal to other belts or to mine cars. These sprays are generally used to alleviate the accumulation of fine coal dust on the floor and ribs of the local area to reduce fire hazard. Usually the dust counts in the atmosphere at these locations will be less than 10 m.p.p.c.f.

In addition to standard spray practices, better dust control is achieved by increasing the quantity of air sweeping the face. While in some cases increased air is necessary to dilute and carry away methane which is being liberated at a faster rate because of the increased penetration into the coal seam, typical of continuous mining machines; in general, more air is directed to the face in order to carry away dust which has escaped the water sprays. Common practice is to carry the air up to the face, over the operating equipment, and return it from the face behind line curtain or by exhausting from the face with auxiliary fans and tubing.

Rotary type roof drills are provided with a vacuum dust collecting system which gathers the dust at its source near the drilling bit, passes it through hollow drill steel and then to filter bags. Dust is filtered out and the dust free air in the collection system passes out to the atmosphere. Dust from percussion drills is collected dry by an approved type dust collector or water is used to allay the dust.

Coal cutting machines have a piped-in water system which terminates at the cutting bar. Water enters the piped system through rubber hose and is discharged through water spray nozzles at the cutting bar.

Coal drills have been provided with a water jacket and hollow steel augers. Water is delivered to the system by rubber hose and it passes through the auger and discharges in the hole near the bit where the dust is made. The wet slurry which is formed falls on top of the "bug dust" or cuttings made by the cutting machine and adds to the wetness of that material.

Coal is usually blasted by compressed air which greatly reduces the amount of fine coal in the immediate area of the charge. The fine coal created by the cutting and drilling operations is wetted down to such an extent during its formation that very little dust is made during the air blasting. Where explosives are used to blast the coal, water stemming bags are used which aid greatly in wetting the dust created by blasting.

Usually the fine and small size coal is so wetted during the previous preparation cycles that additional spraying is not required during the loading. However, if the coal is unusually dry, the blasted coal is sprayed. Each working place has a water hose and valve ready for use at all times for such spraying purposes.

The shuttle car haulage roads are sprinkled periodically to keep dust out of suspension. Calcium Chloride is also sprinkled on the bottoms for a longer lasting control of the dust. Continuing effort is exerted to keep haulage-ways free of loose coal so that dust is not generated by grinding under the wheels of shuttle cars. At the shuttle car discharge points, water sprays are provided and used whenever the coal is being discharged from the shuttle cars into a mine car or onto a conveyor belt.

During most operations employes are frequently provided with respirators which they can use if needed. Some employes are dust conscious and are encouraged to use respirators whether or not they are really needed.

Special high pressure water pumps are used primarily to supply spray water for dust control during mining operations and for fire fighting purposes as well. Water is delivered at a rate of 25 gallons per minute at approximately 100 lb. pressure.

Some evidence of the continued progress in dust control is given in U.S.B.M. I. C. 8205 entitled "A Study of Dust-Control Methods for Continuous Mining of Coal". Out of 15 mines surveyed in three states, at least 7 were in Pennsylvania. Of the 9 mines in which effective dust control was demonstrated, six were in Pennsylvania. Effective dust control was defined as limiting the dust count in the atmosphere to which employes were subjected during actual production time to approximately 35 m.p.p.c.f. Examples of the range of dust counts at operation positions where control was demonstrated are as follows:

Position	Dust Count M.P.P.C.F.
Continuous Miner Operator	2.0 - 35.
Loading Machine Operator	1.1 - 11.
Shuttle Car Operator	1.1 - 36.
Roof Bolter	1.3 - 38.
Timberman	3.0 - 9.3

It is to be noted that all mines used water sprays, most of them at pressures of 300 - 400 p.s.i., and that the volume of air at the working face ranged from 1000 c.f.m. to 15,000 c.f.m. with the preponderance ranging from 3000 - 5000 c.f.m. The one mine which had 1000 c.f.m. was not judged to be exercising adequate dust control.

In connection with silica hazard, the above quoted report states, "With regard to exposure to silica dust, the free silica content of airborne dust at a concentration of 35 m.p.p.c.f. must be 14 per cent or higher to exceed the Bureau's suggested allowable limit." (5 M.P.P.C.F.) "In past sampling experience the free silica content of the airborne dust resulting from working in bituminous coal has not exceeded 5 per cent and has usually been less than 2 per cent. These values were verified by analysis of dust samples collected in intake and return air and at the breathing zones of miner operators at three of the mines included in this report. Thus, for the purpose of this circular, the free silica content of the airborne dust is not considered to be significant."

EXCESSIVE DUST IN ANTHRACITE AND BITUMINOUS COAL MINES ADVERSELY AFFECTING HEALTH

Lewis E. Evans, Special International Representative
United Mine Workers of America, Ebensburg

At the direction of Mr. W. A. Boyle, President of the United Mine Workers of America, we are pleased to join in this program with responsible Coal Operators, Departments of State Government, and other interested citizens of the Commonwealth looking forward to adopting a program which will give added and adequate protection to the health of men who work in the mines. This is in keeping with the United Mine Workers' traditional policy in this State and in every other coal-producing State in the Nation.

If it were possible to compile a record of the number of men who have lost their lives in coal mine disasters and those who have died prematurely due to the fact that their lungs were adversely affected by excessive dust, I believe that those in the second category would outnumber those in the first category by thousands.

Coal Operators and Coal Miners for many years have recognized the fact that dust in our coal mines presents a serious problem but, generally speaking, the emphasis on this problem has been directed towards the catastrophe viewpoint. Coal dust can start and invariably propagates explosions, and in excessive amounts just assuredly it adversely affects the lungs of men who work in the mines.

There can be no denial of the fact that in recent years some improvement has been made in the control of mine dust, and yet there remains room for further improvement. The United Mine Workers of America, Coal Operators, the Department of Mines and Mineral Industries, and the Department of Health recognized this fact several years ago and set about to inaugurate a program to improve the situation. The responsibility for carrying out this program was placed in the Department of Mines and Mineral Industries with the assistance of the Department of Health. Trained personnel were hired by the Department of Mines to conduct studies in underground Anthracite and Bituminous mines. The program has now been in effect about four and a half years. Due to budgetary reasons the program has not been as extensive in scope as it should be, but I am quite certain that it has brought about some needed improvement. The advent of continuous mining machines some years back, especially in the Bituminous region of the Commonwealth, posed some new and varied problems.

The Coal Industry in this State and the United Mine Workers of America have for many years cooperated in an extensive program of mine safety. These efforts, while not being entirely satisfactory to everyone, have brought about improvement in the Industry's safety record. There is need for a broadening of these activities with equal emphasis on adopting additional measures to protect the health of Coal Miners.

Coal mining at its best is a hazardous and health-taking industry. It need not be as bad as the record indicates.

A Coal Operator points with pride when he is able to operate his property for a year, producing say a million or two million tons of coal, without a fatal accident. It is equally important that none of his employees suffered a disabling lung disease in this same year.

Many factors can be talked about to improve the health of Coal Miners and to reduce to an absolute minimum the appalling loss of life and the shortening of the life span among Coal Miners. Probably the most important of all is proper and adequate ventilation. Men should never be required to operate continuous miners on the return side of the machine. All continuous miners should be equipped with sprays and an adequate amount of water, to be used at all times when the machine is in operation. This should also be done in all cases at loading heads. Haulage ways and traveling ways should be free of dust and kept cleaned at all times. All rock drilling machines should be equipped with dust collectors.

The Anthracite Mining Law makes no mention of dust on the inside of the mine. The Bituminous Mining Law has some specific regulations about this question, but certainly could be improved upon.

The Governor's Commission on Mine Safety has for months been studying the present Mining Laws and getting the views of all segments of the Coal Industry. The United Mine Workers of America deplores the fact that we have no representation on this Commission. We believe that a better job could be done by a Commission composed of representatives of the United Mine Workers, Coal Operators, and Department of Mines and Mineral Industries. We are prepared to meet with such a group at any time to discuss the health problems brought about by excessive mine dust.

The Coal Industry and its people have, over the years, met the challenge of many difficult and trying problems. In the same spirit of cooperation much can be done to bring about improvement in the program that concerns the attention of this Conference.

We hope that every effort will be made to strengthen the structure of the present Occupational Disease Act.

We pledge our cooperation to a constructive and forward-looking program.

SOME ASPECTS OF DUST CONTROL IN BITUMINOUS COAL MINES OF CENTRAL PENNSYLVANIA

John S. Todhunter, General Manager
Barnes & Tucker Company, Barnesboro

The transition of mining methods in Central Pennsylvania from the late 1800's and early 1900's to the present time has expressed itself markedly on the physical appearance of men engaged in the loading, transportation, and preparation of bituminous coal. Those people living in coal producing areas can recall, and still on occasion see, the bent back and knotted legs resulting from the pushing of mine cars, the lifting of rocks and timbers, and other physical feats, almost superhuman, required of the coal miner. The gasping breath known as "miners' asthma" and the black and purple scars caused by premature ignition of black powder were commonplace. All of these factors, along with mine disasters, unsightly "gob piles", polluted streams, and grimy coal breakers, have created, and justly so, what is well known to the coal industry today as the "bad image".

Although most of the elements mentioned here, and so well remembered, have been greatly reduced and many eliminated over the years by the serious and necessary action of our legislative bodies, governmental agencies, the United Mine Workers, and those people operating coal mines, the "image" still remains. Removing this image calls for serious work and decisions in areas such as that being presented at this conference.

Practices of the coal mining industry in Central Pennsylvania in controlling dust are similar to those described by others at this conference. Problems of control vary with coal height, ventilation practices, and the character of coal being mined. Central Pennsylvania is noted for low mining heights, soft-natured dust-producing coal, and gas producing strata calling for high volumes of well directed ventilating currents.

The economics of the industry have required the introduction of high-tonnage continuous mining machines and the concentration of men and machine have required unique methods of dust control. Worth pointing out here is the fact that water sprays and "wetting down" were practices in early mechanized processes, and although reasonably effective where used properly, were not as good as methods now offering better control. With the flow of coal concentrated from the heads of continuous mining machines and moving thence in almost lineal flows over conveyors to the outside, or in some cases by transfer with mine cars, points of maximum dust creation are confined and available to water sprays or enclosure.

Continuous mining machines in Central Pennsylvania normally allay dust with 2.5 or more gallons of water for each ton of coal mined. Sprays are located at points liberating dust around heads and at conveyor openings coming from the machine. The effective cleanup of coal spillage and elimination of spillage at transfer points and loading stations is stressed. Respirators are made available to men at dusty locations not easily controlled and their conscientious use, although not general, is attestable to the replacement elements used. Coal transfer points are enclosed to contain dust and sprays are included where required. Ventilating currents, where safe and practical, are conducted over the heads of miners in a direction favorable to dust departure from the man.

Medical research now being conducted in Central Pennsylvania and other areas would appear to offer a means of measuring the degree of disability of miners through coal dust exposure and other factors peculiar to lung impairment. Acquisition of sound scientific data should express the fallacies of the past, improvements to the present, and requirements of the future.

With our industry, more now than ever, faced optimistically with a uniformly improving economic future, the control of dust shall be a necessary center of attention, and the "bad image" of our industry will be removed with the elimination of the "black face".

DUST CONTROL IN ANTHRACITE MINES

Ivor L. Williams, Vice President and General Manager
Glen Alden Coal Company

The mechanization of anthracite coal mines from the hand held hammer and chisel, to the hand operated auger, to the dry jackhammer, brought with it an increase in dust concentration, that necessitated some means of reducing this concentration. Dust control studies were established and helped to bring about the changes that assisted in reducing the dust generated.

During the early 1940's several large companies acquired dust control engineers and began to implement programs which were aimed at finding and remedying conditions where mining created concentrations of dust particles in the air. Later, a central dust control laboratory for the industry was set up at the Anthracite Institute and a full time dust control engineer was placed in charge. By means of lectures, demonstrations underground and in the lab, circulation of literature, and conducting of dust surveys, all members of the Institute became familiar with the problems and their solutions. Dust control measures were adopted throughout the industry.

Early in our dust studies, it became apparent that some air borne dust came from compressed air operated percussion drill which has hollow drill steels through which the exhaust air travels, and thus keeps the bottom of the hole clean in the so called "dry jackhammer." Wet type jackhammers were purchased and materially reduced dust causes. This was a significant contribution to the reduction of dust.

To eliminate the use of compressed air to keep the drill hole clean, various types of solid spiral steels were tried which, however, were impractical. Then we began introducing tungsten carbide tipped rotary auger drills, electric or air operated and noted at once that the dust was very much reduced. The cuttings were brought out of the hole slowly, most were too heavy to become air borne, and there was no compressed air at the collar to blow them about. Most coal drilling is now being done with these machines. Dust counts are below the accepted limits in dry drilling; where they are near the accepted limits, we spray the collar as the cuttings are emerging.

However, we still have the problem of drilling in rock. Where the bottom rock must be taken, as in the advance of some gangways, we try to have this work done at times when there are no workmen on the return air current, except perhaps the driller. He wears an approved type respirator.

The problem where top rock is being taken, or roof bolt holes being drilled, is more easily solved. We are now using stoper percussion drills which return the cuttings back through the drill steel into an "in-line" filter bag. Practically all of the dust is trapped in the bag.

After drilling and blasting, the coal is then loaded out. In the old days this hand loading raised some dust. The advent of mechanical equipment to load the coal into cars also resulted in an increased dust concentration. The only practical means of reducing this was to wet down the blasted cut. In this method we connect the water to existing air lines or run a separate line to the face for wetting down the coal. In some locations we can connect directly to an existing pump. However, in most of our mining area we have a limited amount of water available and we employ a system of portable tank cars that are transported from the water source to the area requiring wetting down. This use of water in eliminating dust has resulted in a number of side advantages.

1. Handy in case of fire.

2. Gets rid of water soluble explosive fumes.

3. Better safety, since the miner gets a better look at roof and sides.

4. More rapid cooling of the face area – gets rid of heat resulting from blasting.

5. Gets methane gases out of loose coal more rapidly.

We tried the use of "wetting agents." However, in view of the fact that we had too much water in our mines the extra outlay for wetting agents was deemed not warranted. We can reduce dust concentration below accepted limit values with the use of water alone.

Another improvement in dust control is concentrating mining into small sections which operate three shifts each day. It is simpler by this method to stagger the working faces throughout these shifts, in dusty coal, so that there are few or no adjacent working places on any one shift. In pitch work, this means that the dust cloud resulting when blasted coal rushes down the pitch does not move into any place where men are working on that particular shift.

At one time we kept a record for determining the progress of our dust and fumes control program. The information compiled monthly showed the percentages of miners and laborers working in dry places as against those in wet places. "Wet places" were those places that the coal itself was damp and did not create any dust concentration, as well as those requiring the use of water to spray the coal pile.

By November, 1958, we had 100% wet places. Since 1958, the number of men involved has increased, as has the mining of deep virgin areas. We could only guess at the percentages, but with the resumption of pitch mining, we do not think that wet places would be 100% now.

When off track shuttle car haulage was substituted for locomotives and cars in chamber mining, a considerable decrease in silica content of air borne dust was experienced. This was the result of not having to use traction sand with shuttle cars, as we did with rail haulage. This also holds true where we have substituted a conveyor (belt or chains) for the previously used rail haulage.

Before this we had tried to use slag and other low silica materials in places of sand on haulage grades, but we could find no substitute which would permit safe haulage.

One experiment now in progress which is practically dust free is the U.S.B.M. project that uses a stream of water 3/8 inches in diameter at 5,000 sq. inch pressure to cut the coal from the solid face.

Another step toward reduction in air borne dust will be the projected hydraulic transportation of coal from working places to surface. The chief benefit here, with regards to dust, would be that we could eliminate one operation which has caused air borne dust.

In conclusion, the anthracite industry recognizes the problem and is doing its best to remedy conditions through the process described previously.

DESCRIPTION OF DUST CONTROL APPARATUS FOR COAL MINING EQUIPMENT

A. Lee Barrett, Research Engineer
Joy Manufacturing Company, Pittsburgh

The coal mining community has put extended efforts into the dust control in mines since the introduction of mechanical equipment. As is recognized by everyone concerned this is a difficult task. Over the years significant strides in dust control have been made.

One of the earlier control efforts was in the Warden Mine of the Pittsburgh Coal Company in 1934. A Goodman double bar cutting machine was being used in this operation in an attempt to cut out draw slate overlaying the coal. This machine cut a 12 inch kerf and made considerable quantities of dust. Cloth filters were used in attempting to control this dust, however, the experiment was abandoned after approximately six months, among other reasons, because it had not been possible to adequately collect the dust and separate it from the air.

In the State of Pennsylvania about 1937 a number of operating companies began applying water to coal as cut or loaded in order to control dust. This called for a great deal of experimentation since coal dust is not readily wettable. Many types of nozzles and nozzle locations were required to best control the dust.

The Pittsburgh Coal Company, at about this time, purchased more than 200 water carrying trucks for their short-wall coal mining machines. These trucks carried 250 to 400 gallons of water each and sprayed water at approximately 10 gal./min. They were successful in reducing the particle count in the vicinity of the operator to approximately 40 million particles per cubic foot. Water was introduced at the end of the cutter bar in some instances and also sprayed at the point where the cuttings exited from the kerf. A considerable amount of work was also done by the Pittsburgh Coal Company and their suppliers, The Jeffrey Company, The Goodman Company and the Sullivan Company, at this time in connection with the spray nozzles, nozzle location and the use of wetting agents as an aid in dust control. Other mines about the country and about the state also installed water trucks and in some instances completely piped the mine with water, for use on cutting machines and loading machines in dust control. As a result dust counts of 150-200 million were generally reduced to less than 50 million particles per cubic foot.

With the introduction of universal cutting machines the problem was intensified but in known applications water has been used on these machines in the interest of dust suppression. Due to the great amount of coal cuttings produced, particle count has not always been below 40 million particles per cubic foot.

The introduction of continuous mining further accentuated the problem of dust control. Many companies studied this problem and I believe all applications of continuous miners in Pennsylvania were supplied with water.

The Joy Manufacturing Company in 1952 began an intensive study of dust control methods in connection with the continuous mining machine. Low pressure water with wetting agents was tried and an experimental application of the American Air Filter type W Roto Clone, installed by the Jamison Mining Company, was studied but both of these approaches were relatively unacceptable. Low pressure water with wetting agents didn't do the job in a dusty operation, and while the type W Roto Clone could clean 6000 cu. ft. of air per minute it was bulky and non-portable due to the fact that it had to operate at all times in a level condition to control the scrubbing water.

A reasonable satisfactory approach was worked out for the Joy Continuous Miner by the use of high pressure water sprays. These sprays were located 3 to each side of the miner, 2 above the ripper bar and 1 below. 8 to 10 gallons of water per minute were used at a pressure of 800 lbs./sq. in. To withstand the continuous action of the water required that the nozzles be made of tungsten carbide. Spray direction

was arranged so that the power of the sprayed particles was communicated to the air around the continuous miner giving it relatively vigorous circulation in two horizontal orbits which were tangent at the center line of the machine. With approximately 5 HP of energy in the water as released, a considerable circulation was set up around the ripper bar giving each dust particle several opportunities to be wetted by the high velocity water emerging from the spray nozzles. Some such arrangement is quite necessary where water sprays are used to control dust. High speed photography, of the order of 1/10,000 second, was used in evaluation and from these pictures it could be seen that spray droplets, even at these high pressurers, were amazingly far apart, two to three feet in the plane of view. The particle sizes were also quite large with the result that a dust particle's chances of being contacted by a given sprayed water particle in a single opportunity were quite small. The re-circulation arrangement, however, provides a number of opportunities for wetting and thus considerable improved dust collection.

During this work a great deal of effort was expended in connection with the use of wetting agents in the water. These results were all negative. It appears that wetting agents require time to work, if given time they will travel through the water and appear at the surface or air water boundries, having done so they reduce surface tension and thus improve wettability. Where wetting agents are used with high pressure sprays they appear not to have time to move to the surface of the droplet and further seem to increase droplet size. In all known high pressure tests the use of wetting agents has reduced the effectiveness of dust collection.

Joy's and other mining manufacturers' work on dust collection has continued throughout the years. Collectors of the baghouse type have been designed and used in connection with roof bolt drilling. Suction extraction through the roof bolt drill has been used in some instances, this is effective, but sometimes impractical due to the fact that the drill steel may become plugged with cuttings. Water has been used in roof bolt drilling, but the mess is so bad that operators will hardly use it.

The Goodman Manufacturing Company has over the years sponsored various research projects in connection with water sprays and the use of wetting agents in connection with cutting machines, loading machines and continuous mining devices.

As mentioned the slate cutting machine used by the Pittsburgh Coal Company in 1934 was manufactured by the Goodman Manufacturing Company, and considerable engineering research effort has been contributed to the development of dust control. An example is one of the more recent efforts as illustrated by Figure 1, this is a view of a boring machine in which water is carried through the rotating shafts to nozzles located between cutter bits in the individual kerfs. This method of dust control is experimental to date and has indicated profitable results. There are problems, however, related to the protection of the spray nozzles, rotating water conduit, and the hozes which bridge the arm extension elements.

Figure 2 shows a Goodman Boring Machine with an experimental exhaust fan installation to aid in the control of dust. The function of this fan is to pick up the dust near the face and project it to the vicinity of a brattice cloth or conduit carrying air from the place. In other experimental installations two fans have been tried, one projecting fresh air towards the face and providing a velocity means of removing dust from the face, the other as previously mentioned, used to pick up this dust and project it to a ventilation arrangement. Both fan projects offer hope for improvement but as can be seen they are unfortunately larger than is desirable, consequently, it is difficult to place them in the most advantageous location.

The Jeffrey Manufacturing Company, as early as 1930, was experimenting with coal dust suppression by means of water piped into the cutter bars on cutting machines. This was relatively successful from a dust standpoint, but at this time there was little, or no water available in the mines for its use. This situation has changed over the years and cutting machines are now supplied with sprays or piped cutter bars, as this arrangement generally reduces the dust very markedly during the cutting cycle as well as the loading cycle which follows.

In 1954 and 1955 experiments were made with water sprays on Colmols. These included numerous types of nozzles, nozzle arrangements, water pressures, and the use of wetting agents. In these experiments a wetting agent proved to be a very significant factor in the laying of dust at the face.

From late 1956 to early 1959 the Jeffrey Manufacturing Company had a continuing study project on face ventilation for continuous miners, some of which was in conjunction with work being done by the U. S. Bureau of Mines. During this study a coal dust suppression means was also investigated which resulted in the testing of an air filter. A considerable amount of time was spent in tests and modifications of this filter. Unfortunately results were not too encouraging and this part of the project was shelved. During this same period Jeffrey Manufacturing Company applied portable exhaust fans on some of their continuous miner applications with considerable success in reducing coal dust laden air in the machine operator area. An exhaust fan was later developed which mixed rock dust with the air, for dispersion downstream.

At the present time water spray systems are supplied on all Jeffrey Continuous Miners, these are the result of considerable amount of test work on each type of machine to best suit the operation of a given design.

Joy, through 1955, continued work in the dust collection field spending almost a year in an attempt to use foam as a dust collection agent. The problem with foam, an effective dust collecting agent, is that it can not be handled. No method of continually blanketing the dust zone was ever evolved. It had many of the aspects of feathers being so light that it could not be projected in a useful way. It is an effective dust control agent and perhaps further experimentation may bring better results.

Jack Warren of the Anaconda Company, at about this time, developed an impingment collector and applied it at various points in their mines. The Joy Manufacturing Company attempted to further develop this unit for use in coal mines. This device shown in Figure 3, was tested under mining conditions in 1955. This unit did a relatively good job of collecting the dust from 6000 cubic feet of air per minute but together with its fan, it was much too bulky to be portably applied to mining conditions. Continued work brought the development of the Joy Microdyne which used many of the impingment ideas of the Warren collector. This unit was smaller in size per cubic foot of capacity and was a step in the right direction. Typical collection performance is shown in Figure 4, a cross-section of the device is shown in Figure 5. A shortened version of this unit was produced in 1957 and tested in a mine in West Virginia. This machine shown in Figure 6 was 12½ feet long, 3 feet 8 inches wide, 4 feet high and could process 12,000 cubic feet of air per minute through a 24 inch duct at 11 (pounds) water pressure. It used 8 gallons of water per minute and was powered by a 30 HP motor. This machine was in the mines for several months but although doing a relatively good job of dust collection as shown in Figure 7 it again was too bulky to be successful as a portable mine dust collecting device. The handling of a 24 inch suction dust collecting tube was formidable.

The most recent effort by Joy to produce a mine dust collector is shown in Figure 8. In this device the impingment section of a Joy Microdyne is included in the entrance section of a mixed flow fan. Incorporating a 20 HP motor the machine processes 7500 cubic feet of air per minute. Including entrance and exhaust section to apply it to a continuous mining machine it is 54 3/4 inches long. It is 19 inches in diameter and weighs 4 to 500 pounds. The concept was to apply this machine directly to the mining machine re-circulating the air in the working place to remove dust. The water discharged from the machine directly into the conveyor of the miner helped to control secondary dust produced by the conveyor discharge. This machine has some of the aspects of a successful dust control device, but still represents a major problem in size as small as it is. Performance of this unit is shown in Figure 9 and a visual evaluation of dust control is shown in Figures 10 and 11.

Further experimentation with these and similar underground dust collection devices will likely lead to better control of face dust than is now possible in coal mines. Much more effective control of dust has been realized at stationary locations such as car dumping points, shaft loading points, screening and preparation plants. At these points there is space available for filter type equipment, this equipment by

its very nature it is quite large since only approximately 2 cfm may be passed per square foot of surface. However, in stationary locations it is usually practical to accommodate large sized units and with these units a 55% plus collection of -5 micron dust is easily realized. Present technology appears to offer no hope of mechanical or inertial collection of coal dust since these methods are not effective enough in the -5 micron range. Electrostatic Precipitators do not appear practical for use with coal dust because of dust explosion hazards.

Over the years the coal industry and its suppliers have attacked this problem with considerable vigor. It is unlikely that the actual effort made by the manufacturers and the coal industry is apparent to either casual or skilled observers unless they have followed all of the work in detail. Because of the nature of the problem, it has involved a great deal of experimenting by the manufacturer and the user, largely on a trial-and-error basis, and under conditions which have made the evaluations of the results difficult. In spite of these difficulties, good results have been achieved. Ample use of good ventilation and water has usually been an important factor. Many efforts have been made to apply mechanical dust collection devices without much success. It is felt that a continuation of these efforts may lead to a more satisfactory solution of the problem.

FIGURE 1

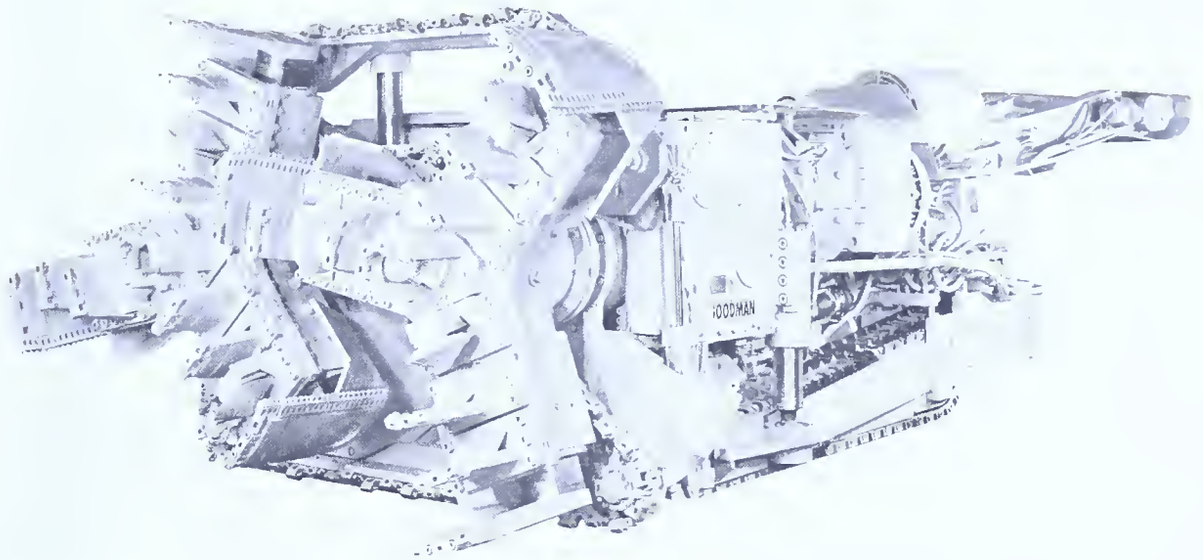


FIGURE 2

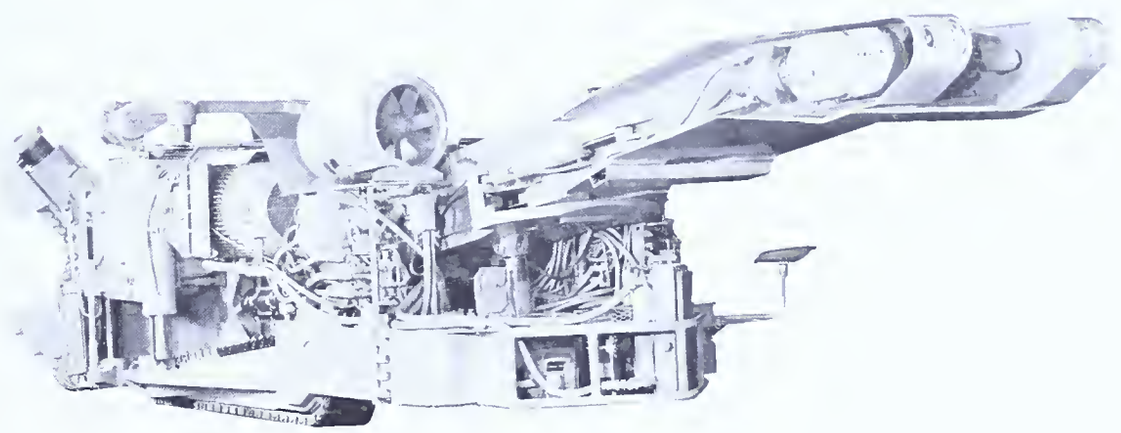


FIGURE 3

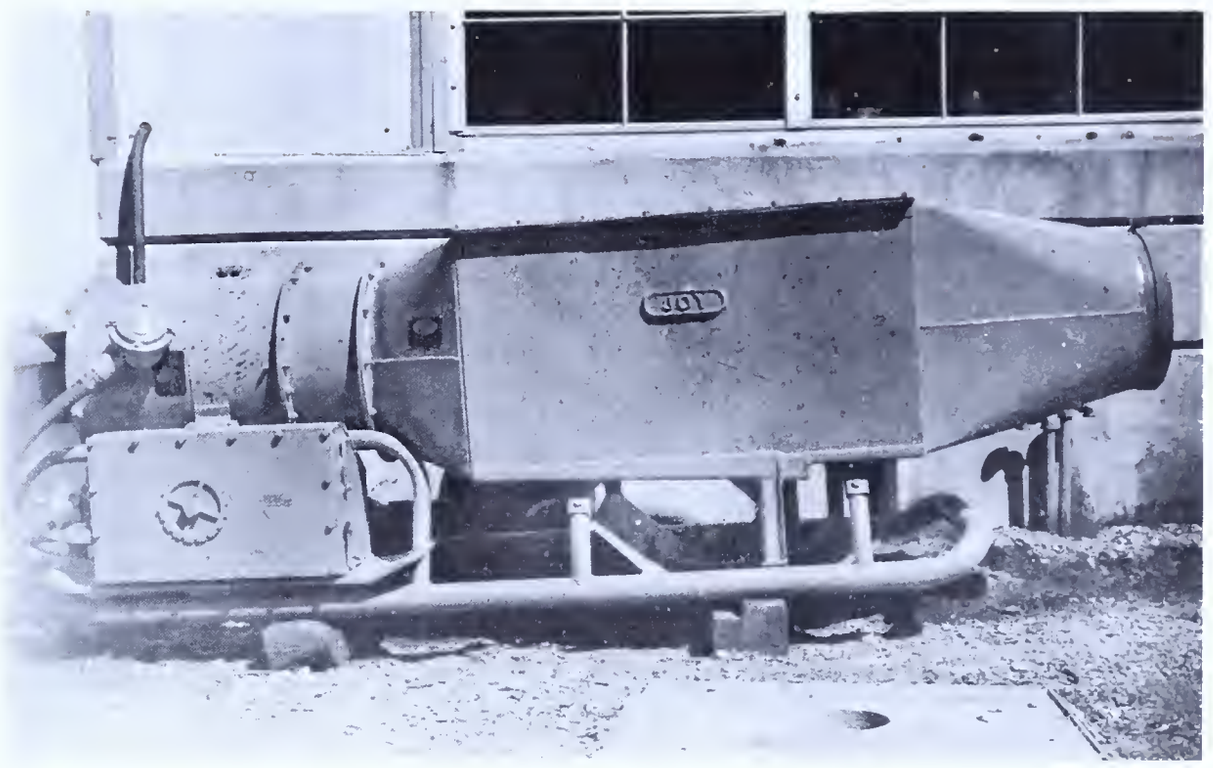
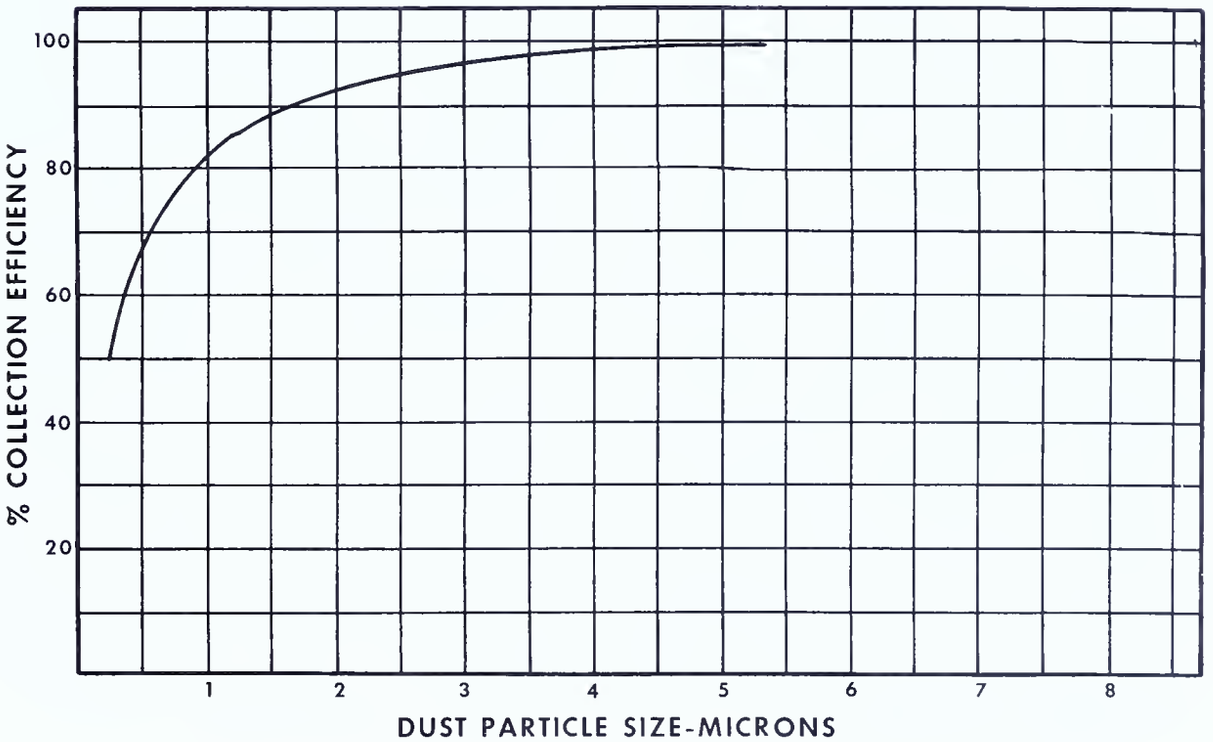


FIGURE 4



Collection efficiency curve by particle count of the JOY MICRODYNE Dust Collector on airborne coal dust.

FIGURE 5

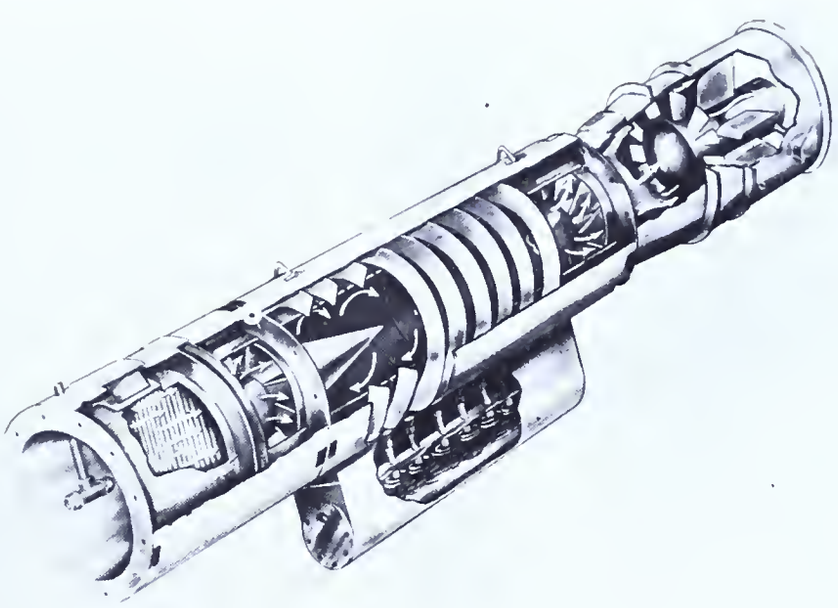


FIGURE 6

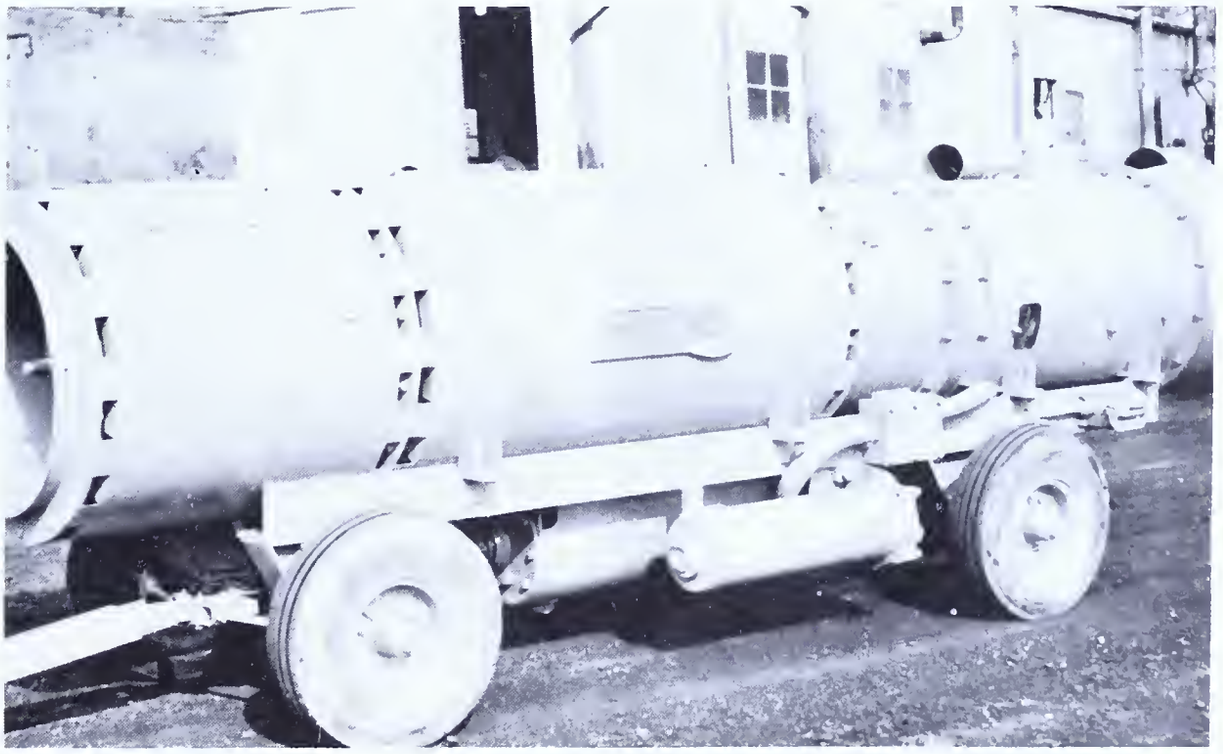


FIGURE 7

DUST CONCENTRATION AT MACHINE OPERATOR

Ref.	Dust Concentration (MPPCF)	Ventilation (CFM)		Remarks
		Total	Collector	
1.	39*		5000	No Brattice. Collector Tubing Opposite Operator to six feet outby.
2.	71**	24,000		No Collector. Brattice two feet inby to four feet outby operator.
3.	10***	19,000	5000	Collector and Brattice. Tubing 3 feet inby operator.

RETURN DUST CONCENTRATION IN CROSSCUT

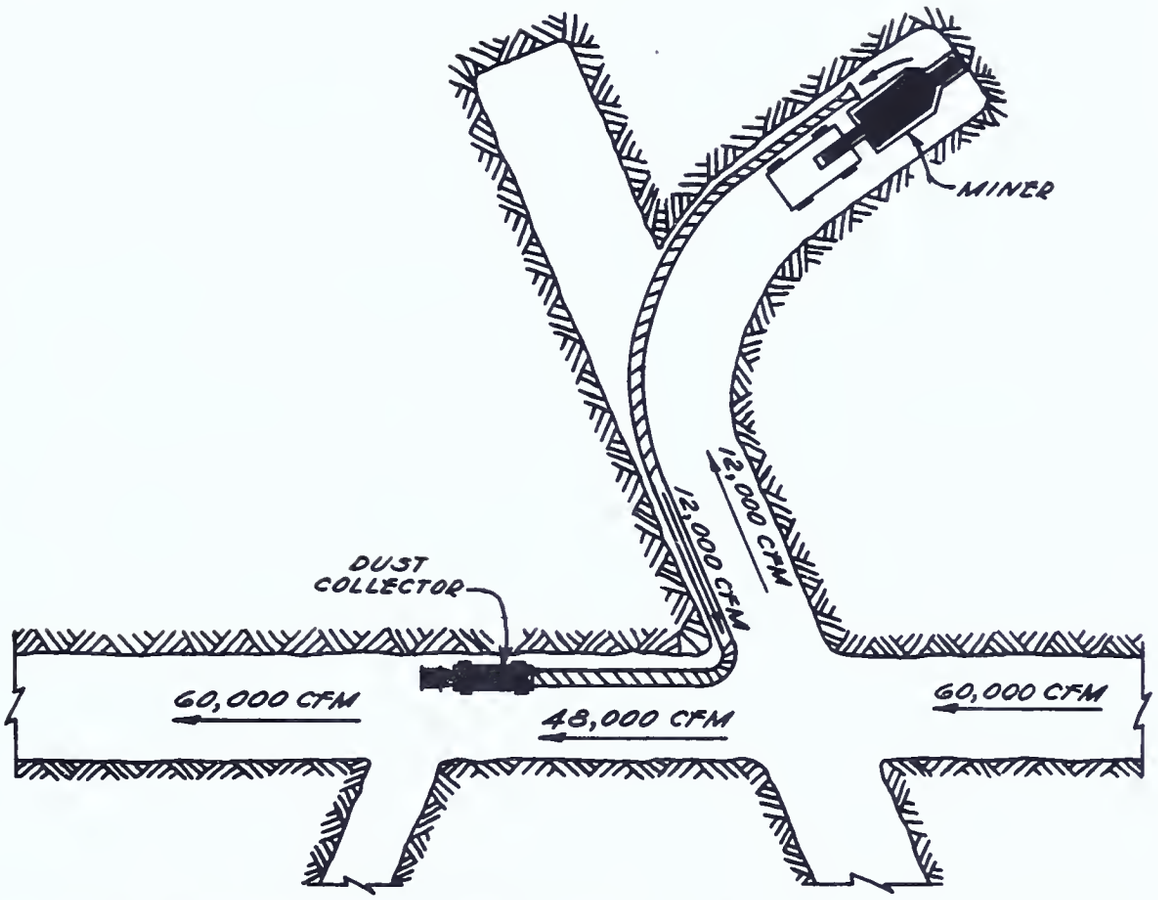
Ref.	Dust Concentration (MPPCF)	Ventilation (CFM)		Remarks
		Total	Collector	
1.	156	24,000		No Collector. Wing curtain only.
2.	14***	19,000	5000	Dust Collector, plus Brattice.

* Average of six samples.

** Average of two samples.

*** Average of three samples.

FIGURE 8



Map of Section Showing Locotion of JOY MICRODYNE dust Collector in o Pennsylvonio Mine During Current Field Tests.

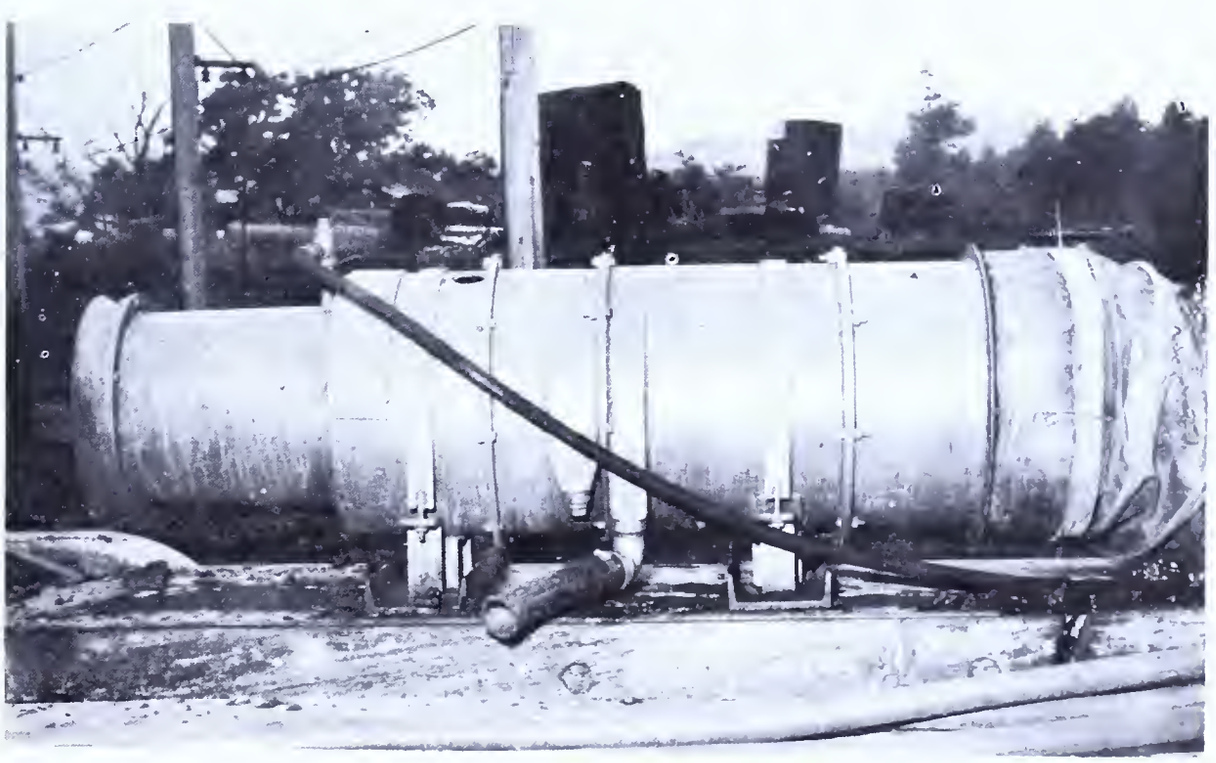


FIGURE 9

DUST CONCENTRATION AT MACHINE OPERATOR

Ref.	Dust Concentration (MPPCF)	Ventilation (CFM)		Remarks
		Total	Collector	
1.	256	--	--	Dust Collector not operating.
2.	16*	12,000	12,000	Dust Collector only.

RETURN DUST CONCENTRATION IN ENTRY

Ref.	Dust Concentration (MPPCF)	Ventilation (CFM)		Remarks
		Total	Collector	
1.	6	12,000	12,000	Dust Collector only.

DUST COLLECTOR EFFICIENCY

Efficiency %	Remarks
99**	By thimble weight method.
90**	By impinger count method.

* - Average of three samples

** - Average of six samples

FIGURE 10



FIGURE 11



OBSERVATIONS ON DUST CONTROL AND INVESTIGATIONS IN COAL MINES BY THE U. S. BUREAU OF MINES

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U. S. Department of Interior, Washington, D. C.

The Federal Bureau of Mines and I greatly appreciate this opportunity to participate in this meeting to tell you something about our interest and activities in connection with coal dust with particular emphasis on chest diseases. We strongly believe this is an occupational health problem of magnitude to both employers and employees which deserves a great deal of attention.

In order to understand the role of the Bureau of Mines, it is desirable that I give you a brief sketch of its history and authority.

The original impetus for the establishment of the Bureau of Mines came from the desire of the Nation's mining industry for a government agency that would foster the development of improved mining and metallurgical methods. Various bills were introduced in the Congress to extend such Federal aid through the creation of a National Department or Bureau of Mines and Mining, the endorsement of schools of Mining and Mettalurgy in the several states, and the establishment and maintenance of mining experiment stations.

As early as 1865 a bill was introduced in Congress by Senator Stewart of Nevada to create a mining bureau. Similar bills were introduced from time to time thereafter. It was proposed in 1892 to establish a Department of Mines and in 1901 to maintain experiment stations. Congress did little in the matter however, despite strong recommendations from industry and government.

Then, in December 1907, four coal-mine explosions, two in Pennsylvania, one in Alabama, and one in West Virginia, killed 691 men. These disasters awoke public interest in preventing the loss of life in mining and to the necessity for investigations and procedures to lessen the hazards to which the miner was exposed.

At a hearing before a subcommittee of the House of Representatives Committee on Mines and Mining in March 1908 testimony was presented by coal miners, coal and metal mine operators, engineers, and geologists. Their concensus, representing that of the mining industry, was that the proposed bureau should concentrate on increased safety in mining, on preventing waste in the mining, treatment, and utilization of mineral products, and that it should work in harmony with the United States Geological Survey, leaving the older organization those problems that were strictly geologic and reserving for the proposed bureau those problems pertaining to mining and metallurgy.

In response to this widespread public demand, the Congress in 1908 appropriated funds to the United States Geological Survey for investigating causes of mine explosions. A station for conducting such investigations particularly on the development of less dangerous explosives, was opened at Pittsburgh, Pennsylvania, in November 1908. To facilitate investigations of disasters and to instruct miners in rescue and first-aid methods, other stations were established in Illinois, Tennessee, and Washington.

The mining industry still wanted a separate Bureau of Mines and a concentrated effort was made for its establishment. The campaign ultimately succeeded, for the Congress, in May 1910, approved "an Act to Establish a Bureau of Mines in the Department of the Interior." This organic act directed the Bureau of Mines to investigate safe mining methods, appliances best adapted to prevent accidents, treatment of ores and other mineral substances, and other technologic subjects pertinent to the mining industry.

This organic act was amended in 1913 to widen the scope and enlarge the purposes of the Bureau by authorizing work "more nearly commensurate with the importance and the needs of the world's greatest mining industry."

Section 2 of the revised Act said, in part,

> "Sec. 2. That it shall be the province and duty of the Bureau of Mines, subject to the approval of the Secretary of the Interior, to conduct inquiries and scientific and technologic investigations concerning mining, and the preparation, treatment, and utilization of mineral substances with a view to improving health conditions, and increasing safety, efficiency, economic development, and concerning resources through the prevention of waste, to inquire into the economic conditions affecting these industries; to investigate explosives and peat; and to disseminate information concerning these subjects in such manner as will best carry out the purpose of this Act."

Undoubtedly because of the high accident rates in the mining industry in the early part of this century, the Bureau's earliest efforts paid little or no attention to the hygienic problems of the industry, instead it concentrated its attention on traumatic deaths and injuries. At that time, the first twenty years of the 1900's, an average of 2,332 men were killed each year in the Nation's coal mines; approximately 500 million tons were produced annually by nearly 700,000 miners in over 6,000 coal mines.

In this regard, dust, especially coal dust, became of immediate interest to the Bureau. In 1910, there was considerable uncertainty as to the explosibility of coal dust in mines, although laboratory experiments had definitely shown the possibility. The Bureau obtained a small coal mine near Bruceton, Pennsylvania, a suburb of Pittsburgh, where it was soon demonstrated conclusively that bituminous coal dust suspended in the air of a mine could be explosive. This interest in the fire and explosion hazards of coal dusts remains important to this day and will probably continue for many years to come. In the intervening years, however, the health hazards from coal dust have become of equal concern to us.

But I don't want to leave the subject of the flammability of coal dusts without taking advantage of some of the information gained by the Bureau in the course of its surveillance of the changes in dust production and hazards with new mining methods and procedures.

Continuous mining produces more fine coal and dust each day than did conventional mining. Also, and very important, is that we are now finding an increase in the finer particles of coal - particles fine enough to become entrained in the ventilating air and to be carried 500 to 1000 feet, and more, in the return airway. We refer to this finer dust as float dust and have somewhat arbitrarily defined it as being less than 200 mesh.

In 13 working faces examined, the quantity of float dust transported into the return airway ranged from 0.01 to 0.18 pound of float coal per ton of coal mined. On the average, 0.1 pound of float coal is transported into the return for each ton of coal mined. About 92 percent of this dust is deposited on the floor and 8 percent on the roof and ribs. At air velocities between 300 to 400 feet per minute, about 65 percent of the dust settles out in the first 500 foot section of the return airway. In two mines for which we happen to have data, at 1,000 feet there was about 0.015 and 0.04 pound of coal in the air per ton of coal mined. Anderson reports that on two cases that he has size analyzed that 43.8 and 25.1 percent of the float dust was 7 microns or smaller. The mass median diameter of all the samples was 8.5 and 12.0, respectively.

Along with this increase in the production of respirable dust there are some other considerations which should be recognized. Calhoun in the Mining Congress Journal says, "It is generally true that continuous mined coal contains more extraneous impurities from roof and bottom, than coal from conventional mining because it is difficult to control cutting into the top and floor." And, not only does the increased production of coal dust require a corresponding increase in rock dust to maintain the 65 percent inert level now required by the Federal Coal Mine Safety Act, but we know that as the coal dust becomes finer, it becomes more hazardous and that as much as 80 percent inert may be necessary to suppress explosions.

Although we don't have much occasion to analyze rock dusting agents for chemical composition, over the past 2 years we have examined 26 samples. Some of them were materials being proposed for use as rock dusts and some were materials already in use. Five of the 26 exceeded the 5 percent limit for total silicon computed as silica. In all, they varied from 0.2 to 60.0 percent SiO_2.

I am not trying to paint an especially alarming picture, but rather to conclude that if the trend toward greater dust production continues we cannot hope to relax our attentions to dust problems, but, rather, may have to increase this effort considerably.

From this background and information, we believe our dust program follows logically. It has two major parts, one dust suppression, and the other studies of methods of dust collection and counting.

Practicalities of dust suppression call for a reasonably inexpensive, simple method which will not introduce new or increased hazards to safety or hygiene. Also, the fewer placers in the mine where application or reapplication of dust control is required, the better.

You are all familiar with the results obtained with water sprays. Wetting agents added to water sprays have varied from virtually no advantage over plain water to a small improvement. Some years ago, experiments were made with foams, and I understand the results were not encouraging.

Since then, there have been new foaming agents developed, and new nozzles designed. Almost two years ago, the Bureau circularized various manufacturers of foaming agents and nozzles as the first step in a program to develop a foam system to allay dust at the source. At that time we listed the following properties as being strongly indicated:

1. Durable foam of short life - about 1 minute or a foam which would be readily destroyed by adding water, or water with antifoaming agent.

2. Small bubbles - about 1/4 inch in diameter.

3. Nozzles to be mounted on mining machines should be relatively small and capable of directing the foam a distance of up to 8 feet from the nozzle.

4. Each nozzle should deliver at least four cubic feet of foam per minute.

5. Working pressure at the nozzle should be from 50 to 100 pounds per square inch, but could be higher if necessary.

6. Foaming agent to be added to the water upstream from the nozzles.

7. Water may vary considerably in pH and hardness.

8. Foaming agent must not interfere with subsequent cleaning plant operations.

The Bureau was offered several foaming agents, but no satisfactory nozzle. As a result, we designed one of our own. It has a liquid flow rate of about 1.25 gallons per minute with a foam gathering capacity of about 15 gallons per gallon of liquid. Each nozzle therefore produces less than 0.2 cubic feet of foam. These nozzles have been redesigned for a larger capacity but the new ones have not yet been tested adequately.

In one experiment, six of the small nozzles were mounted on a Joy Continuous Miner[1] in a field test. About seven and a half gallons per minute of liquid containing approximately 2 percent by volume of a commercial fire fighting foaming agent were used. Potentially this corresponds to roughly 15 cubic feet per minute of foam. Visual observation of the atmosphere indicated that dust generation was reduced slightly. Also, the coal leaving the face was significantly dust free. At the same time it was apparent that a greater quantity of foam is needed.

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[1]Trade names are used for information only, and endorsement by the Bureau of Mines is not implied.

Another experiment first involved 8 nozzles on a Lee-Norse Miner. A cheaper, experimental foam was used at a concentration of 1½ percent by volume in water. There were some difficulties with the water supply, and the results were poor. Then, we changed to 8 larger capacity nozzles with a foam producing capacity of 60 to 80 volumes of foam per volume of aqueous solution. These nozzles had a flow rate of a little over 1 gallon per minute each. At an expansion ratio of 70, this would amount to a total of 75 cubic feet per minute of foam. Again, visual examination indicated some, but not enough improvement.

This seems to be a good place to interpolate that although these results are only slightly encouraging, we are nevertheless optimistically pursuing this work in the belief that the improvement can be multiplied many times. It is also apparent, now, that an additional specification for the foaming agent should be added to the ones with which we started. The foaming agent should produce a foam which will provide as much wetting action as possible.

At the request of a mine operator, a study was made by engineers of the Health and Safety Research and Testing Center on methods of controlling dust along a conveyor belt entry in an operating coal mine, particularly by the use of foam.

Spray nozzles were directed onto the falling coal at a belt feeder discharge point. Mining operations were maintained as nearly constant as possible. Midget impinger samples were taken under various conditions.

At the section belt dumping point, without foam or water nozzles in operation, there was a dust concentration of 11 mppcf. This decreased to 9.5 to 10 mppcf when the water sprays only were turned on, but rose back to the 11 mppcf quantity when a wetting agent was added to the water. When foam spray was used, the dust concentrations varied from 5.3 to 6.9 mppcf average, and with both foam and water in simultaneous operation, there was 6.7 mppcf.

Similar results were obtained at the same time at a main belt entry. Dry operations produced 5.0 mppcf of dust. With water sprays the dust varied from 3.7 to 5.5 mppcf average. Wetting agent added to the water gave a reading of 4.1 mppcf. With foam only the dust concentration dropped to 3.2 mppcf.

I would like to call to your attention, as did Mr. Younkins, Bureau of Mines Information Circular 8205, A Study of Dust-Control Methods for Continuous Mining of Coal, by Anderson, Evans, and Peluso. This recent publication reports on the dust concentrations found in 15 mines where a total of 38 continuous mining machines were employed in various configurations of mining methods. The intake air dust concentrations were from 0.9 to 22 mppcf. The dust exposure of miner operators, their helpers, loading machine operators, shuttle car operators, roof bolters, and timbermen are reported. There is considerable variation between classifications and in each class of work-extending from 1.1 mppcf in one case each for loading machine and shuttle car operators to 580 mppcf in the case of one continuous miner operator. This report is available on request.

Another approach to dust control is in situ wetting of the coal beds by water infusion to induce methane drainage. Currently the Bureau of Mines is studying this effect in conjunction with dust generation by continuous mining machines.

Finally, we have begun studies of dust measurement procedures, sampling devices, and counting methods and equipment. Among our goals are placing midget impinger samples in true perspective in relation to other sampling devices and more nearly absolute values of respirable dusts, and unifying counting techniques so that there will be greater agreement between operators and between laboratories. This does not mean that we intend to abandon the midget impinger. It has been and will continue to be a very desirable method of collecting samples for engineering control and other purposes. We are anxious however to learn more about the meaning of the data developed from midget impinger samples.

RESEARCH PROJECTS PERTAINING TO CONTROL OF DUST IN COAL MINES

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The importance of suppressing dust from the standpoint of the insidious health and the overt explosion hazard is obvious. The tremendous increase in mechanization over the past 10 to 15 years has caused a corresponding increase in dust production. Many feel that this cannot be economically handled by increased spray water and ventilation alone. The cost to all concerned for compensation for men incapacitated for work due to silicosis is enormous. For mine explosions, it is impossible to estimate the cost of human grief and suffering, let alone the dollar cost and loss of equipment and man hours.

The problem is therefore twofold: First, dusts in the respirable range must be increased in size to prevent deposition in the alveolar region of the lung or removed or otherwise minimized and secondly, explosive dust must be suppressed so that in the event of a gas ignition it does not readily become air borne and propagate the explosion.

A broad variety of research is underway to shed light on these problems. Historically, the dust problem was first investigated as a chemical phenomenon. Somewhat later, a thorough physical study concerning size and diffusion rates was popular. Still later, the engineers worked on the problem. A proper approach appears to be a combined effort on the part of all segments of science. Some of the current research shows signs of crossing disciplinary lines and will hopefully shed light on this vexing problem. Recognizing this problem, the Coal Research Board of the Department of Mines and Mineral Industries has authorized a $20,000 research project at Bituminous Coal Research Inc. under Mr. Garvey and Mr. Saltsman; this began February 1, 1964.

I will mention briefly some of the current applied and developmental research activities concerning dusts. Some of those agencies doing research on this problem are: U. S. Bureau of Mines, Bituminous Coal Research Inc., Battelle Memorial Institute, The Pennsylvania State University, British Coal Board, Coal Companies, and Equipment Companies (Government and Universities have no monopoly on applied research.)

In England, wider, two inch bits are being used on cutting heads with a smaller number of bits per head, for example, 27 as compared to the usual 53 per cutting heads. These larger bits produce a higher percentage of coarse coal with the resulting shift of the size distribution curve away from the production of copious amounts of fine dust. Certain problems, of course, are encountered with this device, for example, machine instability due to vibration. There is also lower energy required but higher torque. A positive correlation has been established between increased sharpness and high carbide content with low fines production. Fines production also increases with increased bit age.

Large vacuum cleaner type dust collectors located directly behind the mining machine have proven effective. However, their size creates problems. Collected dust is wetted by water and sprayed on the raw coal as a slurry. English operators have reported that 60% of the dust make is collected. Typical devices under development include cyclone, impingement, and bag type collectors with or without sonic whistles.

Increasingly effective dust collectors are being used for collecting of drill dust from hollow core drilling bits. This type of equipment is standard practice in many mines and was only occasionally used a few years back.

Water infusion particularly is effective in areas where porous strata are encountered. High humidity has long been established as a positive aid to decreased explosion hazards and increased flocculation capability. As a further benefit from water infusion, in many European mines, evolved displaced methane is collected, filtered out and marketed. Spray water studies involve where to put nozzles, what volume of water to use and what pressures should be used. Concerning water sprays, authorities differ on effectiveness of wetting agents and foams. This will continue to be an area for further study.

Although not especially appropriate in a health consideration of dust, testing is underway in using inert dust distribution as part of the explosion prevention program. This procedure, while not decreasing the health hazard, on the other hand, introduces into the settling dust a sufficient weight of inerts that flash explosions will not propagate and spread. Experiments are still underway to secure the best specific gravity material and size consist for recommendation for this purpose. Most engaged in this work are well aware of the need for seeking inerts with a low silica content.

Several new easily applied urethane foams have been developed for use as stopping material. The increased air tightness of such stoppings which results from the use of these plastic foams often results in increased air velocity at the working face. The use of these foams is expected to increase in the future. Also under study are different baffle arrangements designed to cause turbulence and flocculation.

Another interesting approach to increasing floc size has recently been completed at our own State University where research has been completed indicating the advantage of saline aerosol introduction into the air. The addition of a harmless aerosol of fine size to increase settling through agglutination does occur but not as well as expected. Low concentrations of saline were satisfactory. However, reasonable concentrations must be maintained to insure that every dust particle collects many salt particles. The primary advantage of the salt absorption of dust particles is that the material thus becomes entrapped and easily expirated from the upper respiratory tract rather than being drawn deep into the lungs. The corrosive properties of salt, of course, are a drawback of this particular approach.

Some work has been done to ascertain the feasibility of independent ventilation of the mine face to isolate the major dust producing area in the mine. This independent exhaust system would also aid in the control of gas in mines if sufficient safeguards were taken and flammable gases were sufficiently diluted.

I might add that a new nuclear dust explosion prevention device was announced recently. An Alpha radiation source is used to "bleed off" static electric charges arising from moving conveyor belts thus ending explosion causing sparks.

Ideas picked up here will be considered and are quite welcome. Although a wide variety of chemical, physical and engineering approaches have been undertaken to remove dust and minimize the dust problem for the coal industry further research to determine technically feasible and economically sound solutions aimed at the abatement of the dust problem is a continuing necessity.

MEDICAL ASPECTS OF REHABILITATION

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The Vocational Rehabilitation Act of 1954 defines a physically handicapped individual as "any individual who is under a physical or mental disability which constitutes a substantial handicap to employment, but which is of such a nature that vocational rehabilitation services may reasonably be expected to render him fit to engage in a remunerative occupation.

Establishing eligibility for vocational rehabilitation services requires a series of decisions which involve:

Identifying the physical or mental impairment;
Defining functional limitations;
Defining how they interfere with occupational performance;
Evaluating need for vocational rehabilitation services which will overcome or reduce these interferences;
Evaluating the probable outcome of the vocational rehabilitation services.

These decisions require appropriate information about the individual's physical or mental conditions, personal and social adjustment and outlook, education and training, work history, functional limitations, employment prospects, and about the availability of services necessary for his vocational rehabilitation.

Prior to and as a basis for formulating the individual's plan of vocational rehabilitation, there will be a thorough diagnostic study, which will consist of a comprehensive evaluation of pertinent medical, social, psycological, and vocational factors. In each case the diagnostic study shall be adequate to provide the basis for (1) establishing that a physical or mental condition is present which limits the activities the individual can perform; (2) appraising the current health status of the individual in order to determine his limitations and capacities; (3) determining how and to what extent the disabling conditions may be expected to be removed, corrected, or minimized by physical restoration services; and (4) selecting an employment objective commensurate with the individual's capacities and limitations.

The medical diagnostic study shall include:

(1) a complete general medical examination, providing an appraisal of the current medical status of the individual;

(2) examinations by specialists in all medical specialty fields, as needed; and

(3) such clinical laboratory tests, x-rays, and other indicated studies as are necessary to establish the diagnosis, to determine the extent to which the disability limits (or is likely to limit) the individual's daily living and work activities, and to estimate the probable results of physical restoration services.

The major purpose of the medical diagnostic study and evaluation in vocational rehabilitation are:

1. To establish, through competent medical judgment, that a physical or mental impairment is present and materially limits the activities which the individual can perform, as one aspect of determining the individual's eligibility for services as a "disabled" person;

2. To appraise the current general health status of the individual, including the discovery of other impairments not previously recognized, with a view to determining his limitations and capacities;

3. To determine to what extent and by what means the disabling condition can be removed, corrected or minimized by physical restoration services; and

4. To provide a realistic basis for selection of an employment objective that is commensurate with the disabled individual's capacities and limitations.

Although the diagnostic phase of the rehabilitation process is, in most cases, concentrated in the early period of the case, the diagnostic study of the client continues throughout the period of rehabilitation services. Medical diagnostic services may be needed in some cases long after eligibility has been established and rehabilitation services have been initiated. Changing conditions in the client's life or physical status may at any time necessitate re-evaluation of the need for rehabilitation services; there may be need for further diagnostic study as a result of the changed health picture; another medical opinion as to the desirability of medical or surgical treatment may be advisable; or the suitability of the employment objective may need to be re-considered.

The Bureau of Vocational Rehabilitation should provide, or otherwise arrange for, all the medical diagnostic services that are required for an adequate understanding of the individual, his present (and probable future) health status, his needs for medical care or other rehabilitation services, and his capacities, or limitations, for employment.

Included in the broad range of such diagnostic services are:

1. Medical and surgical examinations
2. Psychiatric evaluations
3. Dental examinations
4. Consultation with and examinations by specialists in all medical specialty fields
5. Inpatient hospitalization for study or exploration
6. Clinical laboratory tests
7. Diagnostic x-ray procedures
8. Trial treatment (especially in cases of epilepsy, diabetes mellitus, emotional disturbances, or for differential diagnosis in other conditions)
9. Other medically recognized diagnostic services.

The medical examination done by a general physician who takes an over-all look at the total medical problem of the individual, insofar as he is able, is an examination of great potential significance in case diagnosis and rehabilitation planning. The purpose of the general medical examination, in most cases, is to begin an evaluation of the individual's total medical problem and to establish his current health status. In some cases, however, a specialist's report of the individual's obvious impairment may precede the general medical examination; occasionally a psychiatric examination or psychological testing may appropriately take place before the general medical examination.

Regardless of the type of impairment (an amputated limb or a metabolic disorder, for example), it is important to secure complete data regarding the individual's sight, hearing, muscle tone, skin, heart, lungs and any other factors that might have a bearing on the choice of the occupational objective, the way he may impress prospective employers, or his functioning on the job.

The Bureau's requirement of a total appraisal of the individual's health status through a general medical examination may be met by examinations performed either by general practitioners or specialists who meet the qualifications set up by the Bureau.

Examinations by a specialist in one or more medical specialty fields should be secured in all cases in which there is need for a more thorough study of the particular impairment or bodily system in which the impairment lies, in order to secure a better understanding of the client's condition, possibilities of treatment, and rehabilitation potentialities.

Specialty examinations should be secured in all cases in which they are medically indicated. They should be secured either upon recommendation by the examining physician and approval by the medical consultant, or upon the recommendation of the medical consultant. An ophthalmological examination should be secured in all cases in which visual impairment is suspected; a psychiatric examination should be secured in all cases of mental illness or emotional disturbance.

Inpatient hospitalization for diagnostic purposes should be provided in cases in which the diagnostic study required for an adequate understanding of the client's condition cannot be satisfactorily done on an outpatient basis.

In some communities there exist medical facilities which include the skills of a number of medical specialists, related professional workers and supporting clinical laboratory services, and which thus offer an opportunity for a comprehensive medical diagnostic study, based on pooling of information and integration of the medical and medically related findings.

Such coordination of skills is especially desirable in cases of severe disabilities, or obscure and complex diagnostic problems, and it is recommended that the Bureau arrange to utilize such hospitals, clinics, group practice units or rehabilitation centers whenever it can be established that a carefully weighed and synthesized into a comprehensive understanding of the client's total medical condition. Use of such facilities will often prevent unnecessary duplication of examinations and yield a more complete picture of the client.

In order to secure from examining physicians the best possible medical data and to utilize the medical examination reports to the fullest in diagnosis and planning with clients, the Bureau provides for adequate medical consultation to all its counselors.

The medical consultant can be particularly helpful to the counselor in suggesting significant medical, social and vocational data that should be summarized for the benefit of the examining physician. He also can suggest specific questions to be asked so that the examining physician can more quickly focus upon problems of greatest concern to the agency.

In some situations the medical consultant may participate more personally in making contacts with and interpreting to examining physicians the policies and objectives of the bureau as a further aid to counselors in understanding the client's problems.

The purpose of physical restoration services in the vocational rehabilitation program is to remove or to lessen the physical or mental impairment of the individual served, in order that he may be rendered fit to engage in remunerative employment.

In the 1954 Vocational Rehabilitation Act, as was true for Public Law 113, 78th Congress, there is evidence of legislative intent to differentiate the physical restoration aspects of the vocational rehabilitation program from a program of general medical care. A general medical care program would encompass medical treatment of all kinds of illnesses, ranging from acute conditions to prolonged chronic conditions for which only palliative treatment in terminal stages would be possible.

The vocational rehabilitation program does not have the legal responsibility for furnishing general medical services to the general population; its responsibility is to a relatively small proportion of the population in whom physical or mental disability has resulted in a substantial employment handicap, and for whom there is a reasonable expectation of achieving employability. Moreover, the vocational rehabilitation program does not have the responsibility for furnishing all kinds of medical services for all kinds of conditions; its responsibilities are limited to the treatment of conditions which have resulted in a substantial handicap to employment and which directly affect the employability of its clients.

In some cases, the only service that is needed may be physical restoration in addition to counseling in relation to vocational adjustment. Such cases are clearly within the scope and purpose of the vocational rehabilitation program, provided that the eligibility requirements have been met and the criteria for providing physical restoration have been complied with in each case.

Physical restoration services are those medical and medically related services which are necessary to correct or substantially modify, within a reasonable period of time, a physical or mental condition which is stable or slowly progressive. They include:

1. Medical or surgical treatment by general practitioners or medical specialists;
2. Psychiatric treatment;
3. Dental services;
4. Nursing services;
5. Hospitalization (either inpatient or outpatient care)
6. Convalescent, nursing or rest home care;
7. Drugs and medical supplies;
8. Prosthetic devices essential to obtaining or retaining employment;
9. Physical therapy;
10. Occupational therapy;
11. Medically directed speech or hearing therapy;
12. Physical rehabilitation in a rehabilitation facility;
13. Treatment of medical complications and emergencies, either acute or chronic, which are associated with or arise out of the provision of physical restoration services, or are inherent in the condition under treatment; and
14. Other medical or medically-related rehabilitation services.

Federal financial participation in expenditures for physical restoration is available, provided that (1) the individual is eligible, (2) criteria for providing physical restoration services are met, (3) services are authorized and (4) case data justify provision of the services.

For each individual to whom physical restoration services are provided, the case record shall include: (1) pertinent information secured in the diagnostic study, (2) data supporting the clinical status of the client's disabling condition as stable or slowly progressive, and (3) a plan of vocational rehabilitation, which sets forth the individual's vocational rehabilitation objective, the physical restoration services needed, the way in which such services will be provided and the probable length of time required to achieve the physical restoration objective.

The Bureau should assume responsibility for providing, or arranging for, all the physical restoration services that are needed by the client in order to attain his vocational rehabilitation objective.

In many cases the Bureau should purchase or otherwise provide all the services needed to treat the condition, including physicians' services, hospital care, and drugs. In certain other cases, the Bureau may find that it is more appropriate to arrange for the needed medical care to be provided by another community agency. In such cases, the Bureau has a responsibility for assisting the client in securing the needed care and for assuring that it is of high quality.

Experience in the vocational rehabilitation program, as in all medical care programs, has shown that unforseeable complicating conditions may arise in connection with the provision of physical restoration services, in spite of the most careful planning to assure medical and hospital services of high quality. In addition, certain complications or emergencies may be characteristic of the disease process itself, and their treatment should be regarded as an integral part of the physical restoration undertaken to correct or minimize the disability. These complications may be acute or chronic in nature; they may occur in the hospital or outside. Their treatment is properly a part of the total physical restoration process.

The Bureau should assume responsibility for arranging for all physical restoration services which, in addition to those initially authorized, would be needed for the safety of the client and the achievement of his physical restoration objective and ultimately of his vocational objective.

REHABILITATION POSSIBILITIES FOR MINERS IN PENNSYLVANIA

Thomas E. Williams, District Administrator
Bureau of Vocational Rehabilitation
Department of Labor and Industry, Harrisburg

Vocational rehabilitation is a public service provided by the Commonwealth of Pennsylvania, in cooperation with the Federal Government, to help prepare handicapped persons for gainful employment. It is the process of assisting the disabled to select suitable jobs and to prepare them for a designated vocation through counseling, training, physical restoration, and placement in employment.

All Pennsylvania citizens---man, woman, or child---16 years of age or older who have a permanent disability which prevents them from engaging in gainful employment, but who can be prepared for new jobs, and those who have been injured and are unable to return to their old jobs, are eligible for this service.

Immediately after a handicapped person contacts the Bureau of Vocational Rehabilitation a plan will be started for his restoration if he is deemed eligible for the service. A medical examination by a physician of the individual's own choice will be provided to determine the exact nature and extent of the disability, which must be one that jeopardizes his chances of obtaining and holding a job.

After the physical condition is determined, the individual's social and educational background, his vocational interests and abilities, and previous employment record are evaluated through interviews and aptitude tests. With this information a plan for rehabilitating the handicapped individual is developed.

Services rendered by the Bureau of Vocational Rehabilitation may include:

1. Medical and vocational diagnosis. Through medical examination the extent of the applicant's disability is discovered, his eligibility for services and his ability to meet the physical demands of work are determined. The type of job he can do best is established after interviews and aptitude tests by vocational counselors.

2. Guidance and counseling. These phases comprise a continuous service which dovetail other parts of the rehabilitation process into an organized plan. It begins with the first interview and continues through a satisfactory job placement. Counseling helps the disabled person to understand his assets and liabilities, the cause of his present problems and the steps necessary to correct these difficulties.

3. Physical restoration. This includes many types of medical or allied services which will aid in eliminating or substantially reducing a disability as a job handicap. Included are medical, surgical and psychiatric service, physical and work therapy, hospitalization, dentistry – when an employment handicap, care in convalescent or nursing homes, medical supplies and prosthetic appliances.

4. Training. Suitable employment is provided in many instances through mental and physical training, pre-vocational, vocational and supplementary instruction. This training is provided either to prepare the disabled person for a job or to make him more advantageously employable through added skills and capabilities.

5. Placement in employment to utilize to the utmost the individual's capabilities considering his physical and mental temperament.

Vocational rehabilitation services on which management may draw without cost include effective counseling to salvage and conserve manpower; the evaluation of a disabled applicant's capabilities; aid in restoring and retraining injured workers; expert experience in plant surveys to determine suitable jobs in which disabled persons may be employed; referral of trained, skilled reliable workers who have had the advantage of careful preparation for employment.

Another feature of the service is the follow-up after placement. A rehabilitant is not forgotten after being placed in a position. His performance is watched so adjustments can be made if required. A rehabilitant's case is not marked "closed" until a reasonable period of time has elapsed so both he and the employer are satisfied with the new set-up. A client may return to the Bureau of Vocational Rehabilitation as often as he needs help.

District Offices of the Pennsylvania Bureau of Vocational Rehabilitation are located in, Altoona, Bridgeport, DuBois, Erie, Harrisburg, Johnstown, New Castle, Philadelphia, Pittsburgh, Reading, Wilkes-Barre, Williamsport, and the Pennsylvania Rehabilitation Center in Johnstown.

REHABILITATION NEEDS OF PERSONS WITH CHEST DISABILITIES UNDER THE PENNSYLVANIA OCCUPATIONAL DISEASE ACT

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Much has been written and is available in the literature concerning the clinical and pathological aspects of occupationally-acquired lung disease, but very little has appeared concerning the social and economic aspects. Since the latter follows the former as the night follows the day, this is long overdue.

It will do no harm to restate the highlights of Workmen's Compensation coverage for disabling chest diseases under Pennsylvania's Occupational Disease Act. They bear heavily on what follows. We have been mining coal in Pennsylvania since before the American Industrial Revolution but the Occupational Disease Act has only been with us for 25 years. The most liberal act imaginable, which Pennsylvania's is not, could not hope to remedy all the previous ills generated by more than a century of unconcern. It appears, however, we are still not keeping pace with the present let alone preparing for the future.

1. As amended in 1961 maximum liability for total disability was raised to $12,000, and is "full and complete payment for all disability, present or future, or for death from such occupational diseases arising out of employment by any and all employers in this Commonwealth." (Section 301 a)

2. Compensation for the occupational diseases enumerated in the Act shall be paid only when such occupational disease is peculiar to the occupation or industry in which the employee worked and not common to the general population. Total disability or death must occur within four years after the date of last employment in such occupation or industry. (Section 301 c)

3. Compensation shall be paid only when it is shown that the employee has had an aggregate employment of at least two years in Pennsylvania, during a period of at least ten years next preceding the date of disability, in an occupation with a silica or asbestos hazard. (Section 301 d)

4. Compensation is not payable for partial disability due to silicosis, anthraco-silicosis, or asbestosis but only for total disability or death caused by these diseases, or when they are accompanied by active tuberculosis. (Section 301 e)

5. Since a 1956 amendment, compensation when awarded for the above mentioned lung diseases is paid jointly by the employer (60%) and the Commonwealth (40%). The employer liable is the last in whose employment the victim was exposed to the dust hazard for six months or more. Except that, if it can't be proven conclusively that the disability is the result of the last exposure, then the Commonwealth, i.e. the taxpayer, pays 100%. (Section 301 g)

Even to the uninitiated it must be apparent at once that several inequities result.

1. Payments at the current rate of $47.50 a week provide an existence income for only 252 2/3 weeks until the $12,000 award is exhausted, or slightly under five years. If a recipient survives this, he has nothing but his disability to live with! Incidentally, the initial rates were much lower.

Acknowledgement is hereby made of valuable assistance from Charles H. Bisdee and Joseph Rasefske of the Pittsburgh Area Medical Office and Martin H. Dobis of the Morgantown Area Medical Office, whose experiences substantiate ours.

2. The benefits allowed for chest diseases are significantly different than benefits for workers who suffer industrially incurred accidents, or even for other occupational diseases! A paraplegic now could get benefits for life. Not so a pulmonary cripple.

3. No partial benefits are payable, even though it appears wise use of this factor could prevent subsequent total impairment.

4. Medical benefits are not even mentioned, even though hundreds of these disabled men need oxygen and/or other expensive medication to keep them even minimally comfortable.

5. Disability or death and the resultant claim must occur within four years of date of last employment, even though it is well known that silicosis or complicated anthraco-silicosis, once acquired, is progressive, in some cases at a much slower rate than others.

6. Coal workers' pneumoconiosis (which is prevalent in the bituminous fields) was not even included among the list of compensable diseases until 1956 and then it had to be covered under the omnibus clause, Section 108 (n) of the Act. In other words, miners declared disabled from pneumoconiosis alone were previously not eligible for compensation and cannot now file because of the statute of limitations. Our files reveal there were probably hundreds of these and Dr. Lieben's chest surveys bear this out.

7. The Commonwealth, not the industry, is carrying the burden for most occupationally incurred lung disease although the employer or his insurance carrier is legally responsible for industrial accidents. Is the insidious gradualness of silicosis or pneumoconiosis too involved to classify an insult to the lungs with a visible insult to a bodily extremity?

According to the state's own figures approximately 7,000 miners or dependents are receiving payments under the Pennsylvania Occupational Disease Act. Said another way, about 7,000 Pennsylvania families are receiving for their livelihood 17 million dollars a year, or about the cost of a mere 17 miles of super-highways!

When the Occupational Disease Act was first passed in 1939 there were approximately 215,000 miners in the Pennsylvania coal fields. In 1963 there were fewer than 30,000. In other words, 185,000 men had disappeared from the job market place through death, disability, job dislocation and retirement in slightly over 20 years. This is equivalent, counting families, to the population of a major city about the size of Pittsburgh. That the number of compensable occupational disease cases is only 7,000 is little short of astonishing to me considering the usual length of time worked. The British found many more proportionally, in their own researches.

It would appear that because of inadequacies in the Occupational Disease Act itself, other hundreds of cases remain unknown, unreported, unrepresented and uncompensated and, it must be added, unrehabilitated.

We in the Fund think we know a little bit about rehabilitation and disability. In the fifteen years of our active existence we have referred more than 4,600 miners and dependents to the Pennsylvania Vocational Rehabilitation agency. We have conducted several times that many personal interviews. About 1,900 cases have been reported back to us as successfully completed. I have no recent figures on the number of respiratory disabilities among the referrals but among the success stories chest cases are running less than 12%. It is my distinct impression that either silicosis, anthraco-silicosis or pneumoconiosis has been named as the major disability or a contributing factor in a vast majority of my own referrals,and the trend is sharply upward in recent years. As the number of chest disability referrals increases so does the percentage of rejections and non-rehabilitated closures. And Pennsylvania probably has the best rehabilitation program in all the coal producing states!

Throughout the rest of this paper I will refer frequently to specific case histories. In no way do I wish to imply these are unique cases. Quite the opposite. They are simply examples of patterns which have shown themselves over and over again through the months and years. They were apparent in 1949; they are still with us in 1964.

During these same 15 years dozens of mines have ceased operations. Some have involved the livelihood of hundreds of men, some only a handful. These are not youngsters who are being laid off when a mine closes nowadays; these are men with 20, 30,35 years of service and 20, 30, 35 years of dust accumulation, because the average age of a working coal miner is close to 50 years. Unless they have active and effective help, these men half-heartedly and aimlessly pursue the several courses open to them: collect their unemployment compensation benefits, seek disability classification, or find, in a few isolated cases, the path of rehabilitation and re-employment. Experience shows that it is a year and a half to two years or more before the question of disability is resolved. This is a shameful waste of time and an irretrievable blow to the economy of the family and the community.

Whether by design or accident our present Occupational Disease Law seems to pre-condition men to permanent disability and permanent poverty. In any event, rehabilitation usually is the last resort rather than the first.

We think a perfectly valid case can be made for the rehabilitation of miners receiving compensation for pneumoconiosis. As a point of fact, however, I can think of only one in recent memory who has been accepted and trained. He was 41 when he stopped work, was married with two dependent children still at home. He received his award two years later and shortly thereafter entered a two-year training program at a cost to the State of perhaps $3000. Ironically, had he also qualified for Social Security disability benefits he would have been ineligible for the rehabilitation agency's services because his combined income would have been above their income standard! This man has long since graduated and is languishing at home waiting for someone to hire him at a decent wage (i.e., more than his $42.50/week compensation award) while in the meantime the termination of his benefits draws inexorably nearer. He will be only age 48 when he receives his last check. He cannot even accept the odd jobs he has been offered for fear of jeopardizing his only income! Nevertheless, his is one of the more hopeful case histories. He could earn many times $3000 during the remainder of his work life.

We are not acquainted with all the bituminous miners now receiving awards, but we do know that in central Pennsylvania, for instance, in only the last three years at least 127 were between the ages of 50 and 55, 82 between ages 45 and 50, and 12 under the age of 45! Note, the quoted age is at the time of their award, not age when last worked. They are usually two or three years older by the time their claim is resolved. Under more favorable circumstances a sizeable percentage in these age brackets might be considered as rehabilitation potentials. Almost none of them are.

But staggering as this picture is, we are even more concerned with the hundreds more who are not working and not receiving compensation awards. In my book practically 100% of those under the pension age of 60 should be rehabilitation candidates. The referral rate, however, is not 50%. It is not even 25%. It is just about 15%. And the acceptance rate is much lower.

In April 1958, a large productive mine in the Johnstown area unexpectedly closed its portals throwing 279 men out of work. Over the course of the next several years the Johnstown Area Medical Office staff made contact with approximately 80 or 90 per cent of the men. In spite of prodigious efforts on our part we were able to refer a mere handful, 32 to be exact, for rehabilitation services. Of these, only eight were successfully completed. Just one is still active. The others were lost by the wayside for one reason or another and still keep turning up now and then as persons in need.

Another large mine in the area closed in two cutbacks in 1960. This time 321 men were involved. Our contact record was just as impressive, yet we made only 69 referrals to the Bureau; 28 have been completed, 11 are still active. Thirty were rejected or rehabilitation efforts proved fruitless. The oldest men among the referrals from both mines is still not yet 57 years of age!

There are those who insist that dislocated coal miners don't want to work. This has not been our experience. As the result of thousands of conversations with unemployed and disabled coal miners over the years we are sincerely convinced that the dearth of rehabilitation success stories is far less due to the miner's inertia than to the many roadblocks thrown in his way, by the economy, by the culture, and by the shortcomings in the very laws supposed to help him!

Let me be more specific. One of the men we interviewed was 44 years old when the mine closed. He was married with two dependents. Like most miners he had only an eighth grade education and no work experience except his 26 years as a coal miner. His work history was good; he was even kept on at the mine for some months after the shutdown for maintenance purposes. As part of our own rehabilitation screening he received a thorough medical evaluation resulting in a diagnosis of simple pneumoconiosis and mild emphysema. Because he expressed interest in retraining he was referred to the State Rehabilitation Agency. In due course of time--about nine or ten months in this case--the referral was rejected because the medical consultant in the District Office decided the man would still be working if the mine hadn't closed, and therefore he had no employment handicap! Without an employment handicap he was ineligible for vocational rehabilitation services. About 22 months after his layoff he returned to work in another mine where presumably he is collecting more dust on his way to an eventual compensation award.

Take another case, age 40, with a similar diagnosis and 19 years' work history. This man took himself out of the state on an extensive job hunt, was even hired by an auto assembly plant in the midwest until his pre-employment chest X-ray caught up with him. He was turned down by the plant physician because of the same picture of dust in the lungs. This in the face of all the literature on the subject, which as I read it, clearly indicates that simple pneumoconiosis does not progress once the subject is removed from the dust hazard.

Manifestly these two men were at a disadvantage because of interpretations on the part of the medical men involved whose sincerity we don't doubt but whose judgement we do. They were, on the one hand, thinking of preserving tax monies and, on the other, of protecting the employer from future compensation claims. In the last analysis, they did neither. Subject No. 1 is eating more dust and Subject No. 2 came back home to file a claim within his four years and is on public assistance while awaiting a decision.

Here's another variation on the same theme. A 42-year-old ex-miner had a back disability along with simple pneumoconiosis. He was accepted for rehabilitation services and sent to a technical school for vocational diagnosis and planning. He wanted to learn welding and the training was approved. As luck would have it, the waiting list in that particular course was over a year long. Since this school was one of the very few in Pennsylvania willing and able to train non-high school graduates, our man had no choice except to return home to await his turn. While he was waiting the Area Redevelopment Act opened up new possibilities and he sought its possible comfort only to learn that the school administrators who set up the criteria for the training programs had ruled out persons in his age bracket and with his limited education, probably because of employer demands. The story was just the same under the later Manpower Development and Training Act.

Again I want to emphasize, these are not isolated instances of men with unlucky breaks. I am reporting stories heard over and over again, with but slight variations, in our contacts with these outcasts from our prospering economy. Sad to relate, even the very acts designed to help have their built-in deterrents.

Neither are Unemployment Compensation benefits of help to a rehabilitation program for the partially disabled. Because most coal producing areas are "poverty pockets," they have as yet no public adult trade or technical school facilities so the men have to leave home for training. When they do, of course, they are unable to sign for their checks; they are not considered "available for employment," one of the criteria for eligibility. If they used up all their benefits during a vain search for employment and then went on public assistance, or chose public assistance instead of their unemployment compensation in order to accept rehabilitation training, that too worked against them because the already limited assistance

budget was cut further when the trainee left home and accepted room and board elsewhere. Just one additional insult to the already burdensome inconvenience and discomfort of separation from home and family!

For good measure I will add one of my favorite case histories of a then 45-year-old widower, whose benefits for a partial back disability were cut off before he was restored to employability (it wasn't the carrier's fault the mine closed after the limits of partial compensation were exhausted!), who applied for an Occupational Disease claim and lost, who applied for Social Security disability benefits and lost, who applied for public assistance and lost (he couldn't ask his son to support him and five other sons, nor could he tolerate a lien on the only property he had to leave them), who applied for training of his choice and lost (the psychometrics showed otherwise), who nevertheless did go to school (although training was interrupted for further back surgery), did learn a trade, but now can't get a job because he is seven years older than when all this started!

Nor can I resist mentioning the man who cooperated all the way down the line, did everything anyone could ask of him, gave up his cash benefits, left home and family, learned a new trade, even got a job. But it was out of state and he had to start a new life. He didn't even give up when confronted with the D.P.W. lien on the property he would have to sell in order to buy a new home where he now works. He just stays in Ohio and commutes when he can, while his family languishes in Somerset County without husband and father.

As you can plainly see, these are not exactly incentives even to the toughest minded. In short, these men have lost their former skills, their income, their seniority, their pension rights, their medical benefits, their employability, their community status, their family position, the rights to the fruits of their labor and they are supposed to delight in the benefactions of the welfare state!

Only recently I met again another man who in 1954 when only 41 years old was told by two different specialists he had a third-stage pneumoconiosis and so ought to get out of the mines and be rehabilitated. He was extremely interested in the Bureau's offer to send him to Williamsport for training until he learned what his family income would be on Public Assistance. At that time there were four children at home, the youngest barely over a year old, so he continued to work. Be it known, he received no special job assignments out of the dust over the next several years, perhaps because none were to be had. In 1959 he was in Dr. Lieben's chest survey; his X-rays showed advanced pneumoconiosis with large coalescent lesions in the intraclavicular regions. It was clear by this time that he was compensable and rehabilitation was again recommended but he continued to work for the same reasons as before. The issue was forced in June 1962 when the mine shut down, but it was not until February 1964 that his compensation award was made. In the meantime, in spite of evidence going back ten years, he has not been able to establish an O.A.S.D.I. claim.

Although this man appears to be holding his own fairly well over the past several years, if I read the literature correctly, the prognosis for longevity is poor. Since there has been a worsening of the X-ray picture it can also be said, I think, that the prognosis might have been better had we been able to accomplish a rehabilitation ten years ago.

Another miner, age 49, father of five children under the age of 18, was laid off in August 1960 after more than 25 years service. For 18 months or more he struggled on Unemployment Compensation checks and Public Assistance. He finally obtained a job as janitor in the local school system at a salary of $220 a month, take home pay being not much more than his assistance checks. Even while working in the mines, he had been running into pulmonary difficulties. He pushed himself on that job and he is pushing himself on this job.

A few months ago he received a thorough physical examination and a chest evaluation for the first time in years. The chest specialist advised him to file an Occupational Disease claim because of advanced anthraco-silicosis. His Union officers advised likewise. The patient had a difficult choice to make.

The four year statute of limitations was running out. His pay was now $270 a month. He still had five children to support and Workmen's Compensation payments are limited to about $170 a month and for five years only. He decided to do what so many others have decided to do: work until he drops. "After that," he says, "Public Assistance can take over."

Is this all we have to offer a man who has given the best years of his life to a job and an industry?

Consider also the plight of a 54-year-old miner advised by his family physician to apply for compensation and disability benefits. A chest specialist named by the Union finds him eligible for Workmen's Compensation under the Occupational Disease Act and a claim is filed. He is shortly thereafter examined by the defendant company's doctor who finds him ineligible. The referee appoints an impartial specialist who finds him eligible. Possibly two incomeless years from the date of last work, he is granted a compensation award for total industrial disability. In the meantime he has been examined by the Social Security Administration and their Disability Determination Office and found to be not totally disabled. When awarded his compensation he logically asks for an O.A.S.D.I. reconsideration. Another examination by a specialist finds him ineligible, and again he is denied. No wonder the poor guy is confused. So am I. Is he disabled or isn't he? Is disability really a matter of which doctor you go to as it seems to be in this case and so many others?

This particular chap will run out of compensation benefits long before he can apply for limited Social Security pension which will be drastically cut, not only because he's applying before age 65 but also because he won't have worked for at least seven or eight years. In the meantine, too, his chest disability has been building up, his breathlessness increasing. Maybe at the end of the fifth or sixth year the O.A.S.D.I. determiners are willing to concede he may be totally disabled. However, by that time he has lost his chance because the Social Security disability amendments require that he have worked 20 quarters out of the last 40.

Suppose this same man were 45 instead of 54. On the surface rehabilitation would seem to be indicated. Understandably, the man does not want to jeopardize his cash benefits and neither do the counselors in the state agency. But jeopardize them is exactly what he does by attempting rehabilitation. Unlike the Social Security Act or Veterans Administration benefits which permit awards to be paid even after reemployment, an Occupational Disease claim could be closed when a man seeks rehabilitation and most certainly will be closed if he finds another job, whether it be in the first or the fifth year of benefits. If he waits to draw out his $12,000 he is five years older, and no one can tell me there isn't discrimination in job selection on account of age, F.E.P.C. policy notwithstanding.

What am I to tell a 50-year-old man with three children to support, whose well-meaning doctor has just told him that he has a "chest full of dust" and in the best interest of his health he should get out of the mine before it is too late. Am I to tell him that he has to face an indefinite period of no income? That he can't collect Unemployment Compensation because not laid off? That he is too old to be retrained? That his present skills are obsolete? That his Social Security benefits become diminished drastically unless he gets back to work? That he loses medical benefits, pension rights, insurance privileges? That his only recourse is to Public Assistance? That the State must take a lien on his hard-earned property, all he has to show for his work? That his kids won't be able to go to college because he will lose all his savings. Or that they have to support him?

We can talk all we want about Pennsylvania's social welfare services, but at a time like this their accumulated benefits are practically nil. Small wonder he remains on the job, accumulates more dust and becomes a candidate for a silicosis award as fine nodulations become conglomerations and a stepping stone to an early death.

These then are a few of the reasons why Appalachia remains Appalachia and why Appalaehia so desperately needs help--in spite of Workmen's Compensation legislation, Social Security legislation, vocational rehabilitation legislation, manpower training legislation and new anti-poverty legislation!

Against such an array of disconcerting facts what heavy artillery can we bring to bear? Regardless of all I have said heretofore I am still a steadfast disciple of rehabilitation. I believe that rehabilitation brings out the best in an individual and the best in a democratic society. But even such a worthy cause needs a few strong supports. I am brash enough to think I have learned a few of them.

Some of the more obvious ones first:

1. Occupational disease casualties should not be second class citizens so fas as benefits are concerned. Cash payments should be the same as for industrial accident cases and should be paid to the permanently and totally disabled for the entire period of disability. In no other way can maintenance income be assured.

2. Maximum weekly wage loss benefits should be equal to at least 66 2/3 per cent of the state's average weekly wage to prop up the disabled person's purchasing power. They are not now at that rate in Pennsylvania. In contrast, Canada pays 75 per cent.

3. Rehabilitation should be available to all injured workers--and for the purpose of this paper, lung disease is an injury.

4. Special maintenance benefits as incentives should be provided during the period of rehabilitation and until earning power is fully restored.

5. All occupational diseases should be included in the compensation system, including those complications superimposed on dust accumulation, such as emphysema, bronchitis and the like. After all, this is only considering them as tuberculosis which is already considered. The British have been doing so for years.

6. The statute of limitations for filing claims should not begin to run until the employee has knowledge of the nature of his disability and its relation to his job, and should run until disablement declared. I have met hundreds of miners who were never told by their doctors the extent of their lung damage. Even more important for our consideration, however, is the fact that after a certain stage lung disease is progressive and sometimes it takes more than four years to progress to a disabling degree.

All the above are no more than minimum standards which have been advocated by the U.S. Department of Labor for years. However, more, much more, seems indicated at this time.

7. There should be partial disability payments for simple pneumoconiosis cases and other categories not considered total and permanent disabilities. Disability should be on a graduated scale from zero to 100%, as determined by a team of objective and specially trained evaluators.

8. A diagnosis of simple pneumoconiosis once made should fall clearly within the Rehabilitation Agency's eligibility standards. Certainly this should be true when a laid-off miner has to face pre-employment physicals elsewhere, as most of them do.

9. Any award should not affect a rehabilitation program already started even if and when it puts the client over the agency's income standards. This is not "socialistic" generosity; it is hard-headed protection of an investment.

10. Earlier I spoke of the chaos caused by the sudden closing of mines and the seemingly endless dragging out of plans for the future of men caught in such a crisis through no fault of their own. How much better is the picture of a team of medical, para-medical, and rehabilitation experts entering on the scene as soon as the portals close. Medical men who know mining and miners to evaluate objectively and discriminate among several possible stages of disability. Compensation adjustors to administer any indicated compensation claims, and not only total disability. Rehabilitation counselors to advise and clear

the way for any future vocational possibilities. Social workers to uncover family problems and attempt solutions before they become insoluble. Educators to suggest and improvise training programs to upgrade skills. Placement experts to help guide displaced miners into their next occupational endeavor.

What is wrong with this picture? Screening something like this has been going on in certain coal mining areas of Central and Western Pennsylvania for years but it is a service tacked on to a labor-management medical care program which is unable to provide for any need except medical care. Multi-phase screening ought rather to be a citizen's right to services from the various agencies. For there are state and local agencies doing one or another of every activity listed above!

On the other hand, what is the result of our timid, unplanned, uncoordinated approach? The only screening being talked about today is medical screening. This is good but not good enough. Medical men cannot get together from town to town, let alone county to county, to adjudge the degree of disability or rehabilitatibility. Claims adjustors are alternately tough and compassionate. Rehabilitation and vocational placement people, however earnest, are unable to overcome their outdated and under-financed shotgun approach. School administrators and educators, and above all the taxpayers, do not seem to understand the extent and value of true adult education in the space age, beyond giving it lip service. Social workers and agency planners are stymied by the vagaries of the economy and the sociology of our poverty pockets.

In spite of a bright spot here and there and vast energy expended by a growing number of people, the inevitable result is a growing list of unrehabilitated closures and an even longer list of depressed people in depressed areas.

Actually there is no good reason why every miner shouldn't, and couldn't, be screened in some similar fashion at a check point at the time of termination of employment whether or not he is part of an extensive lay-off. But the numbers available at the time of a shutdown makes this situation a natural for some sort of Federal or State grant program.

11. There is in this country a large and growing number of remarkable facilities known as rehabilitation centers. They have done spectacular work with severely handicapped, including paraplegics, quadriplegics, multiple amputees and the like. The pulmonary cripple needs a similar facility, a center where he too can be completely evaluated as to what he has left and taught how to live with it if that is his only future. Or, as some of my rehabilitation friends like to put it, to add life to his years if not years to his life. Why should he not have the same advantages as other disabled persons? The limited medical care included in the Workmen's Compensation Law doesn't even apply to occupational disease victims. Why the discrimination?

"A worker who is disabled by lung disease is as much a casualty of industrial production as a worker who has lost an arm or a leg. He is entitled to compensation on the same basis and it should be considered part of the cost of production. As a matter of fact, there is something even more compelling about occupational disease since as one Department of Labor Commissioner put it: A worker may be able to protect himself from dangerous machinery but he may not always be able to identify and control dangerous fumes, dusts and gases." The word control is the key word here.

12. There are always two sides to every rehabilitation coin. There is action for continuing health as well as for re-employment after disability. I will leave the matter of dust control to others better qualified to remark on it. But surely prevention is better than recouping one's losses. How long will the Commonwealth, how long will the industry allow preventable conditions like chest disease to develop? We need more research money--whether from State or Federal governments is immaterial--for experimentation in removing men from the dust hazard before they are totally disabled, NOT try to pick up the pieces afterward. We need research into the position of automation as a cause of the rising silicosis rate. We need research into adequate methods of disability case finding so as not to jeopardize a man's job and livelihood and his self esteem.

13. There must be more effort on the part of both State and Federal governments to locate new job-producing industry and services in former coal mining areas. All too often a depressed area is bypassed because the poverty pallor is too obvious and worn bootstraps have a habit of breaking. In truth, our society has rightly assigned the responsibility for welfare and education to the government. The participation of government in the rehabilitation of Appalachia and its citizens is essential, not so much because industry might not otherwise locate in the area, but because industry is not prepared to solve and cannot be expected to solve the human problems of economic, educational and cultural deprivation which are the crux of Appalachia's ills.

In three new domiciliary institutions in Cambria County, built with tax monies, literally dozens of displaced coal miners or their wives have found new jobs and new dignity therefrom. Thus double purpose is served. The combined governments are currently spending billions in one subsidy or another--I am not one to say they are not deserved, whether to industry, to colleges, to the farmer, or to the unemployed disabled!

14. Last but surely not least, since money must be found for all this, why not a Federal coal depletion allowance with all the monies derived therefrom specifically earmarked to be spent to prevent human depletion in the coal fields. Surely the conservation of human resources must share the stage with the conservation of natural resources in our economic picture.

Many of the problems so vividly outlined in the Boone report of twenty years ago are with us still. It will take man sized and highly imaginative programs to dispose of them once and for all. Up to now we have been hunting elephants with BB guns.

MEDICAL MANAGEMENT AND REHABILITATION OF SILICOTICS IN ONTARIO

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Ontario Department of Health, Toronto

As the need for rehabilitation of silicotics in the Province of Ontario has gradually become less, and as we are of the opinion that this diminution has been the direct result of preventive measures which have been taken, it was decided to include both aspects of the problem in this discussion. While it is true that our Workmen's Compensation Board operates a very large and quite modern Rehabilitation Centre in the suburbs of Toronto where an excellent piece of work is done in the rehabilitation of accident cases, no such establishment has been found necessary for our silicotics. It was decided, therefore, that the logical approach would be to review for you the story of what has gone on in the field of silicosis among miners in our Province in the hope that our experience may be of some use to you in Pennsylvania.

Since the subject matter deals merely with what has taken place in one Province, you will recognize that my statements are somewhat parochial in nature. It is dangerous to generalize very much in the field of pneumoconiosis because local conditions can, and usually do, play an important part in the final result produced in the lungs of certain exposed individuals. The components of the inhaled dust, the dust control measures, the selection of the workmen and the local background morbidity of tuberculosis and other pulmonary diseases may all have a definite influence on the end result.

It should be, furthermore, pointed out that while I am talking about men who have developed silicosis in Ontario, you are mainly interested in men who have developed the pneumoconiosis of coal miners in Pennsylvania. The two are not exactly comparable, but insofar as silica and the tubercle bacillus may play a part in the condition in which you are interested I offer you the results of our efforts over the past forty years. We do see some men, chiefly from the Belgian coal mines, with coal miners' pneumoconiosis and we have some reason to believe that they may respond to the same measures as our silicotics.

Hardrock mining in Ontario began in the Cobalt, Kirkland Lake and Timmins areas between the years 1904 and 1911. Our records of silicosis date back to a very small survey of a selected group of miners conducted at the request of the provincial Division of Industrial Hygiene in 1921. The purpose of this investigation was to ascertain if indeed we were producing silicosis among our miners. Several cases were discovered and as a result many things began to happen. Further surveys were conducted and by 1926 the Workmen's Compensation Act was amended to make silicosis a compensable condition. At the same time the close association between silicosis and pulmonary tuberculosis was emphasized.

In 1928 legislation was introduced which demanded the compulsory pre-employment and annual chest x-ray examination of all miners employed in dust exposure for fifty or more hours per month. It was, as noted previously, recognized that there was a strong association between tuberculosis and silicosis. It was felt that individuals with active or even apparently healed pulmonary tuberculosis were, on exposure to dust containing free silica, prone to break down with silicosis or tuberculosis or both. This idea was strongly supported by the work of Dr. Leroy Gardner and his associates and has, I believe, been substantiated by the results which have followed upon its practical application. These pre-employment examinations, therefore, excluded from dust exposure employment, men with radiological evidence of present or past pulmonary tuberculosis and the annual re-examination made it possible to recognize, to remove from the exposure group and to admit to sanatorium any who developed pulmonary tuberculosis while employed in the mines. The evidence in favor of these examinations was, and in my opinion still is, so strong as to justify their implementation on a compulsory basis. Once it is accepted that tuberculosis plays a part in the picture, the voluntary basis of examination has considerably less to recommend it.

I will not discuss this system of examination further at this time as Mr. McCrodan, the manager of the McIntyre Mine has already referred to the prevention program during Monday's discussions. I do think it appropriate to mention, however, that the best rehabilitation program in the world is a poor substitute for prevention.

When silicosis was made compensable in 1926, Ontario had about 10,000 underground miners; not many, compared with the large numbers who have worked in your coal mines. There were, however, enough silicotics discovered to call for immediate action. The mining industry was concerned. Over a hundred silicotics were discovered and these men were in a sad state. On the average they were less than 40 years of age and had an average dust exposure time of about twelve years. They were nearly all infected with tuberculosis and, therefore, unfit for employment. During the next five years there were forty-nine deaths recorded, forty-four of these being attributed to active pulmonary tuberculosis. Remember that these men had been hired without any hint of a preemployment examination and we have no way of knowing how many began mining with active tuberculosis. Another point on which we have little information is the incidence of tuberculosis in the general population at that time. It is known, however, that the overall mortality from tuberculosis in the Province in 1930 was about 52 per 100,000 per year. At that time sanatoria were expanding and pneumothorax was, along with bed rest, the common means of treating pulmonary tuberculosis.

Rehabilitation was hardly a problem because there were few men to rehabilitate. Most of the silicotics entered sanatoria and in many cases, diagnosis was made late in the disease. This is shown by the fact that among those who did die in the late 1920's, the average duration of life after diagnosis was six months.

In 1926 after x-ray surveys had been conducted, an effort was made to vigorously attack the problem. The Workmen's Compensation Act was amended and defined silicosis listing three stages.

1. Ante-primary: slight fibrosis with no physical disability. Provision was made for payment, to men falling into this stage, of a lump sum award of $500. This award was not made for disability but to encourage the workman to leave his dusty job and to assist him in finding alternate employment.

2. Primary: an increased amount of fibrosis with slight impairment of working capacity. Payments to these men consisted of a lump sum award of $1,000.

3. Secondary: pulmonary fibrosis with capacity for work seriously and permanently impaired, or with tuberculosis present. Included in this stage were ante-primary and primary cases where pulmonary tuberculosis was found to be present. Those falling into this classification were awarded pensions of two-thirds of their earnings over the last twelve months in dust exposure. The amount on which this was based was not to exceed $2,000.

Payment of these sums were made on condition that the claimants had been exposed to silica dust in the Province for a period of at least five years and also on condition that the workman, regardless of the "stage" of his silicosis, be removed from dust exposure in the mining industry.

It was soon realized that it was neither practical nor legal to finalize these claims by making lump sum compensation payments. If disability developed or progressed later it was found necessary to reconsider the cases and award compensation on a basis of partial or total disability. The lump sum payment was, however, an attempt to assist these men to rehabilitate themselves and was a commendable effort when it is remembered that it occurred in 1926. It was certainly not a complete success because a fair number of these men actually did later progress to the stage of silicosis but specific figures on this group are not available. This, however, was the situation when compulsory examinations began in 1928.

Gradually the regulations governing compensation payments have been changed and up-dated so that at the present time a man who is considered totally disabled receives 75% of his last year's earnings while employed in dust, based on a maximum wage of up to $6,000. All Workmen's Compensation Board payments are tax exempt.

Through the 1930's a considerable number of new cases of silicosis continued to be turned up yearly until a peak was reached in about 1940. Since then the pattern has been, fortunately, one of decline inpite of the fact that the number of men underground has increased to about 25,000. During the 1930's also other changes were noted. The provincial mortality rate from tuberculosis had fallen to about 28 per 100,000 per year. The average age of the silicotics at first diagnosis had risen to 49 years. The average length of dust exposure before silicosis was diagnosed was now 19 years. However, 70% of the silicotics who died between 1930 and 1940 still had pulmonary tuberculosis listed as the cause of death.

This was a period during which rehabilitation began to play a more active part. Attempts were made to get the partly disabled silicotics out of the dust exposure occupations. Some were given surface employment with the mines but this did not work out very well where outdoor work was concerned. You must remember that temperatures of 40 - 50 degrees below zero are not uncommon (and I do not exaggerate) in our mining areas of Northern Ontario. This was not, therefore, much of an answer for a man with pulmonary disability and who was accustomed to working in a temperature constantly in the 70's. Pulmonary infections were frequent and on the whole this approach was unsatisfactory. A few men were placed at light work such as maintenance jobs, elevator operators, hotel clerks, service station attendants (although here again weather was a problem) and ticket takers at the local theatres. In other words, any simple routine job where the physical demands were not heavy was sought out for them.

It must be remembered that especially at that time, the average miner was a man with limited education who was accustomed to earning his living by physical labor. He could not fit into many light jobs within the community, and in many cases was not a good candidate for retraining. Frequently as many of these men were of European extraction, language difficulties further complicated the rehabilitation problems.

As the majority of these silicotics lived in and around the Timmins area many of those concerned with the problem of how to employ them considered the possibility of setting up some sort of light industry for this specific purpose. Unfortunately, such a project never came into being as there were other factors which conspired against it, the chief of these being the geographical location of the town. It is almost 500 miles north of Toronto and not near any other major center. All materials and finished products would have to be transported by rail so that their cost would be increased beyond practicality. The suggestion sounded like a good one but it certainly would have had to be subsidized and the question was by whom? In a more favorable location it might have proved feasible.

For some men employment was found in other parts of the Province and a percentage of them were convinced to move. However, a fair number of these were not happy in their new surroundings and gradually gravitated back to the mining area from which they had come, only to find that most of the local light jobs were taken up by other partially disabled men or in some cases by men who for purposes of manual work were totally unemployable.

It should here be pointed out that the average rehabilitation officer coming to a mining community is at a disadvantage because he is an outsider. In the case of Timmins, the man was from Toronto, a city nearly 500 miles away. His cause was, however, greatly assisted by interested local people who made it possible for doors to be opened to him. I have in mind especially the local physician who is employed by the Workmen's Compensation Board for the purpose of carrying out the compulsory miners' chest examinations. Dr. William Taylor has worked in Timmins for about 25 years and is a most energetic and delightful person. He is on intimate terms with merchants, politicians, union executives, mine managers and silicotics alike. He is constantly on the look out for light jobs and to my mind has been the most potent single factor in rehabilitation in the Timmins area. He has made the job of the rehabilitation officer ever so much easier by his efforts. The usefulness and the necessity of locally interested men of some stature in the community cannot be over estimated. They are as essential as the rehabilitation man himself and should be vigorously sought out and their services enlisted.

As time went on the picture gradually changed. By the early 1950's the anti-tuberculous drugs were available for use. The numbers of new cases of silicosis continued to decline. The average age at diagnosis of silicosis rose to around 55 years and the average duration of dust exposure before silicosis was about 22 years. The tuberculosis death rate for the Province was now down to 13 per 100,000 and of the silicotics dying, the proportion from tuberculosis was down to 40%. Still pretty shocking but definitely showing a good deal of improvement.

It was wonderful to observe that the tuberculous silicotics responded to the drugs as well as the average non-silicotic patient. There was, however, considerably less clearing of the x-ray changes in the silicotics because of the irreversible nature of the fibrotic changes. The sanatoria now had something more to offer the silicotic than the prospect of several years in bed with the ultimate chance of returning home a respiratory cripple. Improvements were noted and have continued to occur. Some of these men who otherwise would never have worked again have returned from sanatorium and have assumed light work, and what is more important, they are living longer, more comfortably and at home where formerly they were often institutionalized for life.

Sometime around 1954, we began to have anti-tuberculous chemotherapy instituted in some cases where tuberculosis was suspected, on the basis of x-ray conglomeration and progressive shadowing, but in the absence of a positive sputum. We chose to call this "prophylactic chemotherapy", although, the word prophylactic may not be properly used in this case. We do know that some silicotics with active pulmonary tuberculosis (as proven by biopsy or autopsy) do not produce tubercle bacilli in the sputum with any regularity.

By 1956 quite a few of these sputum negative cases were being put on anti-tuberculous drugs and an interesting paper concerning such a group was published in the Canadian Medical Association Journal of May 7, 1960 by Drs. Brink, Grzybowski and Lane. In addition to this work, my colleagues and I carried out a further study of 645 silicotics in 1963 in an attempt to find out the value, if any, of putting these cases on chemotherapy. Although this work has not been published, the results were most interesting. After certain obvious exclusions were made, we were left with two groups of silicotics, 241 of whom had been put on prophylactic drugs and 301 of whom had, for various reasons, not received any anti-tuberculous treatment. The groups were similar in age and in industrial distribution but the ones whose x-ray shadows were more suggestive of superimposed tuberculosis predominated in the drug treated group. On the contrary, those whose x-rays appeared less likely to be complicated predominated in the untreated or control group.

Now this study covered a six year period, 1957 - 1962 inclusive. It was very interesting to find at the end of the study that we had 25 men whose sputum turned positive on culture from the untreated group while of our drug therapy group only two men returned positive culture by the end of the study and in one of these it was positive on only one occasion. When man years of "treatment versus control" were considered, the difference was quite statistically significant.

We, therefore, came to the conclusion that it was a very beneficial preventive measure to administer a course of anti-tuberculous drugs to tuberculin positive silicotics whether conglomeration was present or not. This was in agreement with a statement issued by the American Thoracic Society in October 1961 to the effect that chemotherapy is indicated as a public health measure in patients with nodular silicosis who have positive tuberculin reactions. It was very impressive and left no doubt in our minds that silicotics are prone to develop pulmonary tuberculosis even in a Province where, in the period under study, the mortality rate was now less than 3 per 100,000 and the morbidity rate was about 33 per 100,000 per year.

These Provincial rates refer to tuberculosis of all sites and all stages and for both sexes - so that you can see that we have a fair measure of tuberculosis control in our Province. Yet, of all deaths due to tuberculosis in Ontario in the past three years, 3½% of them have come from our group of about 1,000 mining silicotics. We are pleased to report, however, that the proportion of our silicotics dying of tuberculosis has been further reduced to 20%.

In our recent study we found that only 2% of our silicotics were less than 50 years of age when the condition first appeared and that only 21% were under the age of 60 when first diagnosed. When one considers that many of these men with early silicosis have little or no disability and that the remaining 79% are 60 years of age or older, it is readily seen that our rehabilitation problem is not a very large one.

Now since the men who are over 50 years of age are difficult to retrain or to place at other work they are usually allowed to continue at their customary occupation providing they do not have either active tuberculosis or significant pulmonary disability. They are, therefore, permitted to continue doing the work they know best, in an environment where, due to the tremendous effort at dust control over the past 30 years, the additional amount of dust exposure will not be of much significance. In other words, we try wherever possible to safely leave a mild silicotic at work rather than convert him into a rehabilitation problem.

I do not believe that we have taken any unusual measures to rehabilitate our disabled silicotics. The standard procedures have pretty well been followed. Our success has largely been in eliminating the need for rehabilitation by prevention, supplemented by the additional factor, that men for some reason or other have for the past 40 years been entering the industry at an older age than formerly. The age at which silicosis now is occurring approaches the average retirement age and has minimized our problem greatly.

Whether our experience is of any use to you is open to some question. There is the unsolved problem of what causes the massive fibrosis of coal miners. On this there is no unanimity of opinion. Numerous world authorities discussed this problem at the pneumoconiosis conference in South Africa in 1959 and a variety of opinions was expressed. It may be that tuberculous infection does play a part in the production of some of these massive lesions which are usually accompanied by disability. It may be that a course of anti-tuberculous drugs administered to tuberculin positive coal miners at the stage when coalescence begins would have a good effect. It may well be worth a controlled study among a group of your miners because as far as I am aware such a study has not been reported in the literature.

The question of the possible association between the massive fibrosis of coal miners and tuberculosis, is, I am well aware, not as clear cut as in the case of the silicotics. I do, however, think that there is still enough evidence available to encourage one to keep an open mind on the subject. No less an authority than Professor Jethro Gough made the following statement at the Pneumoconiosis Conference in Johannesburg in 1959. "If massive fibrosis is an infective form of pneumoconiosis, there seems no satisfactory alternative to the tuberculous hypothesis".

In summary then, it may be said that rehabilitation of men with silicosis has two chief aspects. The primary job is to handle those who are currently disabled. They must be divided into those who are totally unemployable and those whose disability is only partial, and who may be placed at light work or retrained. Among these are those who are amenable to treatment. Along with these may be grouped those few young men who develop pneumoconiosis early and seem to progress at an unusually fast rate. We do not have the authority, except in the presence of active pulmonary tuberculosis to remove these men from exposure, but we do put some energy into hopefully encouraging them to get out of dust and find other employment or be retrained. It is suggested that the retraining of such individuals might be done as a legitimate charge against workmen's compensation in the stage before disability develops.

There is also the secondary job of those interested in rehabilitation. This is the long term program of prevention which if successful will ultimately pay dividends by decreasing the numbers of those needing assistance in finding alternate employment. By attacking the cause of the disability, the picture can be radically changed.

We, therefore, continue to take pre-employment and annual chest x-rays of all applicants and miners. We still try, through government and voluntary agencies to keep a close check on the incidence of tuberculosis in the population and we hope that our mining areas receive special attention. We still do not relax our dust control program in our mines. We still put as many as possible of our silicotics on prophylactic anti-tuberculous chemotherapy. We still hope to remove tuberculosis from the causes of death of our silicotics . . . . . in other words, we fully realize that there is no room for complacency in our situation and that constant vigilance will be needed if we wish to maintain our present progress.

THE PENNSYLVANIA OCCUPATIONAL DISEASE ACT AND HOW IT WORKS

Edwin M. Kosik, Esquire, Chairman
Pennsylvania Workmen's Compensation Board, Harrisburg

I will proceed by offering a brief history of the Workmen's Compensation laws in this state, and then a discussion of the pivotal provisions of the Occupational Disease Act and the manner in which they apply.

Prior to the advent of social legislation, Pennsylvania, like many other industrial states, provided no means for compensating work injuries. The courts provided the only forum for injured workers. An employee without means and often ignorant in the ways of litigation had to compete against experienced and adequately compensated corporate counsel. The result was obvious.

Remedial social legislation to correct this inequitable state of affairs was first contemplated in 1911. After a necessary constitutional amendment the General Assembly enacted the first Workmen's Compensation Act in 1915, to be effective in 1916. It provided for an elective system of coverage, whereby either party could reject or accept its provisions. In subsequent years, up to and including 1939, various repeals and amendments were made. In 1939, the original Act was reenacted. This law, as amended, constitutes the present Workmen's Compensation Act.

The first Occupational Disease Act was enacted in 1937 as a supplement to the Workmen's Compensation Act. The statute enumerated particular occupational diseases, but denied partial disability in the anthraco-silicosis cases, as does the law to this date. To aid an alleged burdened coal industry, the Legislature included a provision whereby a portion of the scheduled payments would become the liability of the Commonwealth. Notwithstanding, the coal industry rejected the Act and questioned its constitutionality. Before this litigation was completed, a more acceptable Act was adopted in 1939. Its acceptability was rejected by the anthracite coal operators. In 1946, the United Mine Workers of America and its operator signatories entered into an amended agreement which included the general acceptance of the provisions of the Occupational Disease Act by the operators.

Throughout its history, the Act has been amended in various particulars. Without amplification, it can be reasonably concluded that the amendment history has followed a trend toward liberality: to extend benefits rather than to restrict them.

Today, we meet with respect to PNEUMOCONIOSIS as an occupational disease. It is my understanding that special emphasis will be placed on anthraco-silicosis. For this reason I will more or less address myself to this disease under the statute.

A. Who is covered under this law?

In every contract of hiring made after October 1, 1939, and in the case of every contract of renewal or extension of employment by mutual consent, it is presumed that the parties accept the provisions of the law. This presumption stands unless an employer rejects the provisions by proper notice, or if there is an agreement, in writing, between the parties that the provisions are not to apply. In any case, the indication is required to be filed with the Department of Labor and Industry.

Once accepted, the rights between the parties are surrendered to those existing and provided for under the Act.

The workers covered by the Act are employees in the usual definition of the word. Excepted are those performing agricultural services, domestics, casual workers and independent contractors. The Act does not exclude executive officers of a corporation who have been elected or approved by the board of directors.

B. What diseases are covered?

The Act defines "occupational disease" in fourteen enumerated instances, plus a "catch all" provision. In twelve instances, disease may be contracted "in any occupation" where there is contact or exposure. In one instance the disease of tuberculosis is restricted to exposure in the case of nursing. Also in one instance there is coverage for disease of the heart and lungs for temporary or permanent total disability of full time salaried firemen. The "catch all" provision applies to diseases "to which the claimant is exposed by reason of his employment."

In announcing the conference on Pneumoconiosis, there was issued a pamphlet identifying various occupational diseases of the lungs. Included were pneumoconiosis, anthracosis, silicosis, anthraco-silicosis, miner's asthma, emphysema and bronchitis. Accepting this as a correct statement of the diseases caused by dust, it appears that all are not enumerated as diseases in the Act. Except for asbestosis, not considered here, only silicosis or anthraco-silicosis are enumerated under the Act. The others, if occupational diseases, must be established as such under the "catch all" provision.

This brings us to the two statutory provisions pertinent for today's conference. Section 108 (k) applicable to the silicosis category, and Section 108 (n), the "catch all" provision. They read as follows:

> "(k) Silicosis or anthraco-silicosis (commonly known as Miner's Asthma and hereinafter referred to as anthraco-silicosis) in any occupation involving direct contact with, handling of, or exposure to dust of silicon dioxide (SiO_2)."

The "catch all" section reads, in pertinent part, as follows:

> "(n) All other occupational diseases (1) to which the claimant is exposed by reason of his employment, and (2) which are peculiar to the industry or occupation, and (3) which are not common to the general population . . ."

For an occupational disease to be in the dust or pulmonary category, it must be established under either section. It should be noted that, unlike Section 108 (k), the "catch all" section (n) is not restricted to occupational diseases of the dust or pulmonary category.

C. What is required for entitlement to compensation?

Let us take a hypothetical case of a claimant who is totally disabled as a result of silicosis or anthraco-silicosis, or who has died from the disease. The employee, or his statutory heirs in the case of death, to be eligible, must first establish that the disability or death occurred within four years after the date of last exposure in an occupation or industry in which the disease is a hazard. This period has varied over the years, but has progressed to the present four-year requirement. The period is established and based on reasoning that the diseases are progressive and often insidious. Earlier medical reasoning established that if the disease were to manifest itself, it would probably occur within the four-year period. Another reason for the period has been to set a cut off point for litigation purposes. In any event, recent medical opinion now suggests that the disease may manifest itself as a disabler some time after the four years. The State Department of Health has suggested that a reasonable extension of the four-year period to ten years should be considered.

Once compensable disability or death occurs within the four years, there is a notice requirement of twenty-one days. Unless notice is given within one hundred twenty days, compensation will be barred. It has been determined that, for notice purposes, the compensable disability does not begin until a claimant knows that he is disabled. Our Courts suggest that this occurs when a physician so advises a claimant. Once notice is given, a claim petition must be filed with sixteen months. In the case of death, the sixteen-month period runs from the date of death or the last payment of compensation in the case of a lifetime award.

Once a timely case is filed under Section 108 (k) for silicosis or anthraco-silicosis, it becomes necessary to establish the following requirements stated in Section 301 (c), to wit: (1) That claimant was exposed to dust of silicon dioxide; (2) That total disability or death was caused by the occupational disease; (3) That the disease is peculiar to the occupation or industry; and (4) That the disease is not common to the general population. There is an additional requirement under Section 301 (d) that the employee have an aggregate employment of two years in the Commonwealth, out of the ten years next preceding disability, in a hazardous industry.

The statute provides for a presumption that the disease arose out of and in the course of employment, Section 301 (f). The presumption is not conclusive and arises if it is shown that immediately before disability, the claimant was employed in an occupation or industry where the disease is a hazard. In the case of the anthracite mining industry, our court has consistently taken judicial notice of the fact that this is a hazardous industry. The presumption would, therefore, arise in the bulk of these cases.

Where the presumption applies, a claimant would be required to prove only the disability and the aggregate employment requirement. The burden would then shift to the defendant. Our Courts favor liberality in the establishment of the presumption in any type of case. In substance, a presumption that the employee was engaged in a hazardous industry or occupation eliminates the proofs of Section 301 (c), that the disease is peculiar to the occupation or industry and that it was not common to the general population.

If a claim is not predicated upon disability or death from silicosis or anthraco-silicosis, and it is not an otherwise enumerated disease, it must be established under the "catch all" provisions of Section 108 (n). Examples of dust diseases which might fall into this category are emphysema and bronchitis. In one case our Courts have held that emphysema is not an occupational disease because it cannot be shown to be peculiar to an industry. It is important to note that, in the case of silicosis and anthraco-silicosis, the compensation is payable only if the disability is total or the cause of death. Then, the amount payable is a scheduled amount. If the disability is established under the "catch all" provision, there is no restriction or limitation as to amount, and compensation is payable for partial as well as total disability.

A claimant who proceeds under the "catch all" provision to establish an occupational disease not otherwise enumerated, must still establish the same requirements contained in Section 301 (c) and applicable to the enumerated diseases. Under the "catch all" provision, the claimant must prove: (1) That he was exposed by reason of his employment; (2) That the disease was peculiar to the occupation; and (3) That it was not common to the general population.

A number of recent cases have put an emphasis on the requirement that the disease be "peculiar" to the occupation or industry. Unfortunately, these same cases offer little assistance by way of definition. Some early authority interprets the meaning of "peculiar" to be a disease which is commonly caused by the occupation, or the usual instance or result of the occupation; the critical words being "commonly" and "usual." In any event, there is an increased importance attached to establishing that the disease was peculiar to the occupation or industry.

The Act contains other provisions which are too numerous to intelligently present in the time allowed at this conference. Before concluding, however, it is important to briefly discuss a provision which was included in the Act in 1952, to be effective in 1953.

Section 301 (g) provides that the employer generally liable is that one in whose employment the claimant was last exposed to a hazard regardless of time. There is an exception in cases of silicosis or any disease which develops to disability after five years' exposure. In this instance the only employer liable shall be the one in whose employment there was exposure to a hazard for six months or more. In the 1952 amendment, it was further stated that where it cannot be conclusively proven that the disease arose from the result of the last exposure, then all of the compensation shall be paid by the Commonwealth. The provision was included to help relieve a financially burdened industry. It has also aided the claimants, for the Commonwealth is expected to expend twenty-one million dollars in the fiscal year of 1965. Because of this liberal support on behalf of the Commonwealth, it behooves all parties to assume greater responsibility in the administration and trial of occupational disease cases.

The Workmen's Compensation legislation touches the lives of more people in the Commonwealth than any other statutory provision in existence, except possibly for the Unemployment Compensation law. It is intended that the legislation be liberal and it is important to keep liberal. Often, this very liberality is blamed for abuses. Although liberality and abuse have no association, the fact of abuse has led to stringent measures which are directed to eliminate the liberality which the Legislature intended. Unfortunately, the deserving claimant suffers. Constant vigilance on the part of all concerned to recognize and stop abuses will serve to reflect confidence in the entire system.

It is hoped that the limited presentation made by me will contribute some constructive basis for discussion in this phase of the conference.

THE COST OF THE OCCUPATIONAL DISEASE ACT

William C. Diosegy, Comptroller
Department of Labor and Industry
Commonwealth of Pennsylvania

It is my purpose during this presentation to show exactly how much money has been spent over the past 23 years by the Commonwealth in payment of claims under the Occupational Disease Law.

At the outset I would like to make it clear that I am not offering any editorial opinion whatsoever.

My presentation will deal strictly with facts--facts taken from the actual records.

For this purpose I have prepared a series of charts to which I now call your attention, asking at the same time that you refer to the mimeographed sheets which have been placed at your disposal.

In other words, by following your mimeographed sheets, which are, by and large, duplications of what you will see on the charts, you will be able to discern the financial facts involved.

Page 1. The Occupational Disease Act was passed by the state legislature in 1939, imposing upon the Commonwealth the responsibility of sharing payments with employers in the payment of damages for occupational diseases contracted by an employe arising out of and in the course of employment.

Thus, you will note that in the fiscal year 1942, the Commonwealth made payments to claimants under the terms of the Act.

In that year, there was a total of 200 valid claims filed under the Act and as you can see from this chart, the Commonwealth paid out a total of $425,556.61. This, I'm sure you will agree, was a rather modest sum, even in terms of the dollar value of the early forties.

For the next several years the situation showed little change. In 1943, for example, the Commonwealth paid out approximately 575 thousand dollars.

In 1944, 1945, '46 and '47, the amount expended stayed at a stationary figure of 625 thousand dollars.

In '48 and '49 there was a drop as the Commonwealth paid out only 375 thousand dollars per year on all claims.

Then came 1950 and '51 and a jump to 675 thousand dollars a year.

In '52 and '53, it was 825 thousand dollars each year.

In 1954 the total cost of claims paid was 512 thousand 500 dollars.

Then came the big jump. In 1953 the legislature amended the law to state that in those cases where death or disability is not conclusively proven to be the result of such last exposure, all compensation shall be paid by the Commonwealth one hundred percent. This amendment has placed the burden of one hundred percent payment of claims squarely on the Commonwealth in almost all cases, as it is almost impossible to conclusively prove that disability or death is not the result of last exposure.

The results of this amendment are clearly reflected in payments made in the fiscal year 1955.

Note that in that year the cost of financing the Act was almost 3 million dollars.

That, mind you, is a jump from around one-half a million dollars over the preceding year--or a rise of almost 600 percent.

Now note, if you will, how expenditures have jumped by leaps and bounds since 1955.

5 million, 755 thousand in 1956.

8 million, 99 thousand in '57.

Up to more than ten million in 1958.

There was a drop to 8 million, 310 thousand dollars in 1959, but that was because we ran out of appropriated money and so that was all we could pay.

But then back to the upward swing in 1960 - - almost 11 million dollars.

In 1961 and '62 it was over 14 million.

In 1963--almost 16 million.

And so--on and on.

For the fiscal year 1964 it's 17 million dollars.

1965--it will be 19 million.

And in 1966--21 million.

So, I'm sure, you can see where we stand. From a modest beginning in 1942 of less than a half million dollars, we have now come up to 21 million dollars in 1966.

That means that for every dollar spent by the Commonwealth in 1942, we will spend 42 dollars in 1956.

And that figure is based on the law as it stands as of now.

On page 2 of your mimeographed forms you will find a percentage breakdown of the payment splits between the employer and the Commonwealth over the period from 1939 to the present.

Note that in the beginning both the employer and the Commonwealth were charged under the law with paying 50 percent of the bill. After that, the employer's share was steadily increased and the Commonwealth's share accordingly decreased until September 30, 1951. At that point the employer paid 90 percent, and the Commonwealth 10 percent. After that however, the split became 60 for the employer and 40 for the Commonwealth. But in 1953 the law was amended so that in almost all cases the Commonwealth now foots the bill one hundred percent. We have taken note of this earlier in our discussion.

Page 3 of your sheets shows how the maximum payments have increased over the years since the law was first enacted.

Note that in 1939 the maximum amount that could be collected for silicosis, anthraco-silicosis and asbestosis was 3 thousand, 6 hundred dollars.

Since then, the law has been amended seven times, the latest amendment becoming effective November 29, 1961, so that the maximum payment is now 12 thousand dollars.

And now, just to bring you up to date, I'd like to give you the breakdown between Bi-Weekly Payments and Initial Payments for the 1965 fiscal year.

Total bi-weekly payments will amount to 15 million, 379 thousand dollars. In other words this is our total pay-roll under the Occupational Disease Act for the '65 fiscal year.

Total initial payments for the same fiscal year amount to a total of 3 million, 621 thousand dollars.

By way of explanation, an initial payment is the first payment that a beneficiary receives. The payment is a retroactive lump sum--representing coverage from the time the disease was incurred up to the time the award was made.

And that's the story, Ladies and Gentlemen.

As I said in the beginning, I am reporting only.

These are facts--facts in terms of dollars and cents.

I trust I have been able to make it clear to all of you just what is happening cost-wise in the Commonwealth by reason of the Occupational Disease Law.

Thank you very much for your kind attention.

COST TO THE COMMONWEALTH FOR OCCUPATIONAL DISEASE CLAIMS

FISCAL YEAR	AMOUNT OF MONEY EXPENDED FOR O. D. CASES BY COMMONWEALTH
1942	$ 425,557.67
1943	574,442.33
1944	625,000.00
1945	625,000.00
1946	625,000.00
1947	625,000.00
1948	375,000.00
1949	375,000.00
1950	675,000.00
1951	675,000.00
1952	825,000.00
1953	825,000.00
1954	512,500.00
1955	2,844,586.00
1956	5,755,414.00
1957	8,099,641.30
1958	10,181,534.29
1959	8,310,424.31
1960	10,801,386.37
1961	14,548,613.63
1962	14,040,000.00
1963	15,925,000.00
1964	17,000,000.00
1965	19,000,000.00
1966	21,000,000.00

In 1942 . . . . . 200 claims paid

In 1964 . . . . . 7,366 claims paid

MAXIMUM AMOUNT OF COMPENSATION PAYABLE AS AMENDED UNDER THE OCCUPATIONAL DISEASE LAW: FOR SILICOSIS, ANTHRACO-SILICOSIS AND ASBESTOSIS.

ACT EFFECTIVE	MAXIMUM AMOUNT
10- 1-39	$ 3,600.00
7- 1-45	4,000.00
7- 1-49	5,000.00
1- 2-52	6,500.00
8-24-53	7,500.00
3-30-56	10,000.00
1-30-60	10,500.00
11-29-61	12,000.00

PERCENTAGE OF COMPENSATION PAID AS AMENDED UNDER THE OCCUPATIONAL DISEASE ACT: SEC. 308-(a)

IF DISABILITY OCCURS BETWEEN	EMPLOYER	COMMONWEALTH
10-1-39 and 9-30-41	50%	50%
10-1-41 and 9-30-43	60%	40%
10-1-43 and 9-30-45	70%	30%
10-1-45 and 9-30-47	80%	20%
10-1-47 and 9-30-51	90%	10%
After 9-30-51	60%	40%

The Occupational Disease Law was amended in 1953 to read, that in those cases where disability or death is not conclusively proven to be the result of such last exposure, all compensation shall be paid by the Commonwealth one-hundred percent.

THE IMPACT OF THE OCCUPATIONAL DISEASE ACT ON THE ECONOMY OF THE COMMONWEALTH

Arnold D. Smorto, Esquire
Ebensburg

"In 1963 the coal industry of this Commonwealth produced 87,597,009 tons of coal. Consumption of coal has risen substantially chiefly in electric power utilities, coke ovens, retail deliveries, cement mills and other manufacturing or mining industries. According to the U.S. Chamber of Commerce, in 1962 exports of bituminous coal gained almost 10% and exports of anthracite coal gained 30% over 1961. Of approximately 87 1/2 million tons of coal produced in this State in 1963, 47 3/4 million tons were transported by rail, 17 1/2 million tons by water and 13 1/2 million tons by truck.

"When the cost of the coal produced in Pennsylvania, is translated into wages, services, utilities, materials, repairs, railroad, navigation and trucking costs, new equipment, machinery and research, we discover that the coal industry has been responsible for the channeling of millions and millions of dollars into the economic vascular system of Pennsylvania. In fact, when we talk of the coal industry and the allied and satelite industries which revolve around and prosper by it, we further find that we are dealing with a multi-billion dollar enterprise upon which the economy of this great State so heavily depends.

"Therefore, we must keep the prosperity and the welfare of the coal industry clearly in mind when we consider the enactment of any law or the amendment, modification and supplementation of any existing law which may directly or indirectly affect coal mining in this State. We should be zealous to help "coal" develop its potentialities and enable it to meet the competitive challenges of our times.

"It is certainly extremely laudable to attract new industries into Pennsylvania. But it is extremely important that we expend just as much effort, and in fact more, to protect those industries, such as the coal industry, which have for many years past and will for many years to come be the foundation stones of our economy.

"No industry has had more ups and downs, no industry has been more buffeted by the highs and lows of economic storms, no industry has had more competition, foreign and domestic, than the coal industry of Pennsylvania. And no human being has more patiently and courageously and loyally withstood the effects of these economic storms that the coal miner of Pennsylvania. And in its fight for survival the coal industry of this State has received no subsidy, federal or state, but it has been able to lift itself by its own bootstraps to survive and to meet head-on the powerful challenge of modern competitive fuels. To the extent that the coal industry has succeeded in its battle to survive and prosper, to that extent the economy of Pennsylvania has benefited and improved.

"Therefore, because the coal industry means so much to the prosperity of Pennsylvania, as we fulfill the task assigned to us in the Governor's Conference let us ask: "What can we, the people of Pennsylvania, do for this all important industry which has and will continue to be an integral part of the economy of our State?"

"The answers are obvious. We must encourage those who have invested their capital in the coal industry of this State to continue their present visionary programs for increased development and progress in coal production and consumption. By the same token we must encourage the men who work in the mines, to remain at their posts, and pass on to others the art and skill of mining coal. The coal industry does not merely face a crisis by way of new capital expenditures for safer and more competitive productive mines, but it also faces a crisis by way of new human recruits to man and operate highly expensive units of machinery under conditions of concededly greater hazards to property and to life, to limb and to health than exist in any other industry in the United States.

"We can begin by recommending the retention of Section 301 (g) of the Occupational Disease Fund to claimants who have, during their mining careers, worked for more than one employer. We can increase and extend the benefits of the law. We can eliminate the statute of limitations in the case of anthraco-silicosis, an admittedly progressive disease, to permit the application for and the recovery of compensation even partial whenever total disability or even partial disability occurs. We should enact a separate section to cover "coal miners' pneumoconiosis" and provide that fibrosis and/or emphysema in coal miners shall be presumed to have been caused by their occupation unless conclusively proven to have originated from non-occupational factors. We can provide for partial disability compensation to those coal miners who, afflicted by occupational disease, are advised to and must leave the coal industry. Partial compensation will provide them with an income during their period of industrial displacement, provide them with an income, if, because of their chest X-rays, and lung condition, they are refused employment in other fields. Partial compensation will provide them with an income while, through rehabilitation, they are treated for their health and trained in new skills and trades.

"We must recognize in the law that there is no difference between a man who is totally and permanently disabled as a result of occupational disease. Each should receive compensation for life. Yes, there are many ways in which the Occupational Disease Act can and must be improved. These matters will be taken into consideration specifically by other sections of this conference. But in so doing, we cannot afford to take one backward step. On the contrary, we must courageously, humanely and fairly move forward. We must set our aim and goal on improving, enlarging and supplementing rather than on weakening, diluting or otherwise emasculating the Occupational Disease Act of Pennsylvania.

"But, during the deliberations of this conference you will receive complaints that the cost of our Occupational Disease Fund is and will be too great. This is not so. I have already pointed out the benefits and the contributions in material and human investment of the coal operations and coal miners to the economy of Pennsylvania. This investment by far justified and outweighs any cost which Pennsylvania has thus far, or will in the future incur under the Occupational Disease Act.

"In order to allay the fears of those who feel that the cost of providing compensation under the Act and particularly under Section 301 (g) of the law to those afflicted by the ravages of incurable and admittedly progressive miners' pneumoconiosis or anthraco-silicosis, let me state that we have reached the crest of the wave of occupational disease claims.

"In 1948, there were 110,226 outside bituminous coal mine employees in Pennsylvania. In 1963, there were only 26,210 such employees in the coal industry of this State. This represents a drop of 76.24%. In 1948 we had 81,179 inside bituminous coal miners in Pennsylvania. In 1963 we had only 16,032, or a drop of 80.25%.

"From these statistics we must conclude that the bulk of the growing number of occupational disease claims filed in recent years has arisen from the group of coal miners who have been employed in the coal industry since 1948. In the drop in those employed in the coal industry and who are exposed to its dust hazards has now been reduced to 80.25% from 1948 to 1963, it is reasonable to conclude that in the future the number of claims will be diminishing in proportion to and parallel the decrease in the number of men who now work in and are exposed to the dust hazards of the coal industry.

"The Compensation Department of District No. 2 of the United Mine Workers of America, which comprises 18 counties, has been in recent years one of the most active in filing claims under the Occupational Disease Act. To further allay the fears of those who anticipate a continued flood tide of claims, I wish to point out that in District No. 2 we have noted a drop of more than 50% in new cases processed in 1964 in contrast to those processed in 1963.

"Many of the present occupational disease claims in our District are those filed by coal miners who have retired and are receiving pensions from the United Mine Workers Welfare and Retirement Fund. However, we sadly note that our pensioners are dying at a rate faster and greater than new applications are received. This is another reason for dramatic decrease of new claims in our District.

"To summarize, it is reasonable to anticipate a reduction in the amount of claims because first, there are less men employed in the coal industry and, therefore, less men exposed to its dust hazards and, secondly, because the proposed plans of dust alleviation will reduce if not wholly eliminate the incidence of occupational lung disease. Such being the case, we should be prepared to improve and enlarge the scope of the Occupational Disease Act along the lines previously suggested.

"But let us assume for the sake of argumentation that there will be no decrease in the amount of new claims and we might be tempted to cut back appropriations to the Occupational Disease Fund. If, for example, a disabled coal miner is denied compensation what difference does it mean to the taxpayer if that coal miner is paid relief from the Public Assistance pocket or receives compensation from the Occupational Disease Fund pocket? But to the coal miner there is an enormous difference. Nothing is more degrading and nothing is more demoralizing to a coal miner who has worked so hard and dangerously to find himself, with health irreversibly broken, dependent upon public charity and public dole. We cannot afford to leave in the hearts of this hard working contingent of our labor force a feeling that their State is unjust and ungrateful. If we do that to these people we do a graver injury to their spirit and their morale than any savings in taxation could compensate. A continously improved Occupational Disease Act can become a boom and not a blight to our economy and to our working morale and well being.

"Consequently, in considering the enactment of new laws or the modification, amendment or enlargement of present laws directly or indirectly affecting the coal industry, let us be constantly mindful of the importance of that industry and its people to the economy of Pennsylvania. Whatever we do and whatever results from our efforts in this conference will in great part beneficially or adversely affect an industry which is extremely vital to the health, prosperity and progress of Pennsylvania."

THE FOUR YEAR STATUTE OF LIMITATIONS

Thomas B. Noonan, Esquire
Compensation Attorney for the Tri-district U.M.W.A.

Mr. Chairman, Secretary Young, Ladies and Gentlemen:

A review of the program reveals the ostensible purpose of this gathering is of a dual nature:

(1) To review the pneumoniocosis problem in the Pennsylvania coal mining industry; and

(2) To make recommendation for the reduction and prevention of the disease.

Preliminarily, I know all those attending this meeting are whole-heartedly in favor of preventing the disease,--if anyway possible. Similarly, all present are in favor of reducing the disease and its dastardly effects,--if possible. There are other special sessions concerning themselves with those specific phases. Let us hope that the meetings will engender not only enthusiasm, but constructive suggestions in their humanitarian aims. We certainly wish them well.

In this particular session, we are dealing with a "fait accompli"--the damage is done. The question that concerns us is: What are we going to do about a situation where a man is now totally disabled due to anthraco-silicosis? More particularly what, if anything, are we going to do about extending the time in which an afflicted employee might pursue the benefits under the Pennsylvania Occupational Disease Act? Our meeting this afternoon is listed as a Special Session on Workmen's Compensation. The Occupational Disease Act is predicated on an acknowledgement by the Legislature that total disability can arise as surely from occupational diseases as from accidents,--and that the problem must be met as it exists today.

Chairman Edwin Kosik very succinctly explained how the Occupational Disease Act works. Mr. Diosegy pointed the finger at the cost factor, especially illustrating the sharp rise in the number of claims filed and the periodic increases in maximum awards provided by the Legislature. Attorney Arnold Smorto graphically illustrated how occupational disease awards fit into the economic picture.

At this time, it might be appropriate to inquire where the four year Statute of Limitation fits into this particular discussion. Certainly, it was not inserted because of any sex appeal to instill life into the Conference. Rather must there be some kind of a ratio between the four year Statute of Limitations and the specific cost to the Commonwealth of Pennsylvania. To the many persons present here, the mere mention of Section 301 (c) automatically conjures up one of the most relevant parts of the Act. It is the period of time in which an individual, totally disabled from anthraco-silicosis, is permitted to file a claim under penalty of being denied the benefits of the Occupational Disease Act. I know of the presence of many here, however, to whom Section 301 (c) might be a complete stranger. A specific reading of the Section might, therefore, be in order.

Section 301 (c) of the Pennsylvania Occupational Disease Act (Act No. 284, June 21, 1939, P.L. 566, as amended) reads as follows:

> "Compensation for the occupational diseases enumerated in this act shall be paid only when such occupational disease is peculiar to the occupation or industry in which the employe was engaged, and not common to the general population. Wherever compensable disability or death is mentioned as a cause for compensation under this act, it shall mean only compensable disability or death resulting from occupational disease and occurring within four years after the date of his last employment in such occupation or industry."

A careful reading will show that the Legislature recognized two particular causes of action:

(1) A lifetime claim; and

(2) A fatal claim.

As the Act has been interpreted in the law arena, an individual must become totally disabled from the particular disease within four years "after the date of his last employment in such occupation or industry", --with respect to anthraco-silicosis, and its various "cousins", we are talking about the coal industry, anthracite and bituminous primarily, although there are other occupations wherein a silica hazard exists. Therefore, my remarks are not to be interpreted that the silica is exclusively a by-product of the coal industry only. With respect to a fatal claim which, by and large, is a separate and individual claim on the part of a widow or other dependents, the death must occur within four years after the date of his last employment in such occupation or industry.

It is pertinent now to make inquiry as to the reason why Section 301 (c) was inserted into the Act. Preliminarily, it was a recognition of the fact that the occupational disease is a progressive disease and insidiously wrecks the health of an individual as the years go by. Secondly, there was competent medical authority advocating that if total disability was to occur, it would occur within a certain period after the last exposure to the hazard. Finally, there was a strong pressure to the effect that there must be an end to litigation and potential liability on the part of the employer and/or insurance carrier. In the Appellate Courts, this fact appears to be a popular one in citing the reasons for the insertion of Section 301 (c) into the Act. Let us, for a moment, dwell on the foregoing.

There is no doubt about it, all medical authority is in complete agreement that the occupational disease is a progressive disease. Unlike accident cases under the Workmen's Compensation Act, there is a particular "gray zone" during which time it is difficult to pinpoint the precise time when an individual becomes totally disabled due to anthraco-silicosis. A man falls off of a ladder, or has his arm mangled in an industrial machine, and we can set precisely the time of his disability. Such is not the case with an occupational disease. Individuals react differently to different types and degrees of exposure. Therefore, there can be no quarrel that an occupational disease is a progressive disease.

The core of the problem stems from the fact that, initially, there was competent medical authority of record that if total disability was to occur ,it would occur within a certain period after the last exposure to the hazard. As we know now, science and medicine cannot give us an accurate or workable yardstick as to when an individual will become totally disabled due to the occupational disease after he leaves the hazard. Originally, it was thought that a one year statutory period would suffice. However, subsequent Legislature amended the Act to extend the Statute to three years and still later to four years. The four year Statute of Limitations is in effect today. I certainly do not mean to be critical of the practical approach in deciding on any statutory period; however, it must be realized that it is exactly just that,--a practical approach. Because it is a practical approach, it stands to reason that many individuals, though their resistance to the occupational disease might be stronger and might successfully combat the disease during the statutory period, nevertheless, they eventually fall victims to the same cursed disease.

How is the four year Statute of Limitations working out after these many years? It is far from conclusive if we are motivated by strict humanitarian consideration. By that I mean it covers just a certain percentage of men who would be otherwise eligible. Our office experience in processing these claims reveals that from five to seven men per week solicit our aid and would be eligible claimants under the Act excepting for the provisions of Section 301 (c). There is no doubt in my mind that after being informed of the provisions of the law, and the fact that the men were ineligible because of Section 301 (c), that a strong temptation would present itself to fabricate employment records. Certainly, no one would subscribe to anything of that nature. However, in the mining industry, it is almost an impossibility to corroborate each and every employment record of each and every claimant under the Act. This is particularly true where individuals have worked with various independent operations, be they proprietorships, partnerships, or other type of business associations.

There is some question whether or not new life can be breathed into a case that apparently was stricken down by the provisions of Section 301 (c). I refer to a case where an individual might last be exposed to a silica hazard on June 1, 1958. To qualify under the Act, he would have to become totally disabled before June 1, 1962. Obviously, if he had no employment period exposed to the silica hazard after June 1, 1958, and he filed after June 1, 1962, he would be a victim of the provisions of Section 301 (c). The question arises, however, as to the validity of any employment period exposed to the silica hazard after July 1, 1962. It would appear that any bona fide employment at a place where the silica hazard existed, would appear to instill new life into a claim as far as Section 301 (c) is concerned for the Section provides that total disability must occur "within four years after the date of his last employment in such occupation or industry". Conceivably, however, such a claim might fail due to the pitfalls of Section 301 (d) which states, inter alia, that the employee must have had an aggregate employment of "at least two years in the Commonwealth of Pennsylvania, during a period of ten years next preceding the date of disability, in an occupation having a silica or asbestos hazard". That, however, is a story in itself. For those that care to pursue it, the Pennsylvania Superior Court commented on this matter, in some detail, in the case of Peter Czepukatis.

Permit me at this time to make some personal observations. Perhaps I should use the word "convictions". Silicosis is not curable. It is a progressive disease and does damage even after one departs from the hazardous occupation. Anthraco-silicosis reacts differently on different individuals. The physical make-up and the general physical condition, internally, of the employees differ. This reaction can vary considerably depending on the degree of exposure; where the employee works, inside the mines, in the breaker, stripping operations, time limit of exposure, and other side factors.

There is no norm or push button method of determining when a claimant might become totally disabled due to anthraco-silicosis,--medically or otherwise. We therefore find ourselves at an important crossroad. We must be intellectually honest in changing any phase of the Statute of Limitations or its elimination. We must ask ourselves are we geninuely interested in compensating men who have paid the price - men who have become totally disabled in an admitted hazard contributing to the general economic welfare? The answer consistently has been that we are so interested and we continue to be so interested. Then, if that is so, we must next ask ourselves whether we are interested in a blanket coverage for all so afflicted (full humanitarian factor) or are we interested in compensation for only a certain percentage of those afflicted (cost factor)? It then remains for a decision as to where do we go from here regarding the Statute of Limitations. If the motive is humanitarian, the Statute of Limitations should be abolished, whether it be one year, three years, four years, five years, or ten years. If that were done, it would mean any employee, totally disabled from silicosis and showing the necessary causal relationship between the disease and his employment, could recover regardless of when he left the mines. That is not so radical a thought, for those who would equate such a matter in dollar values are reminded that the life expectancy of these men is dangerously low.

If the economic factor (cost) is the approach, then there must be a candid admission that we can accommodate only so many--a certain percentage--and legislate accordingly. It is not proper to hide behind other screens. Should the economic factor prevail, the question then arises: How much can we afford to pay? Determining that, the Legislature should then proceed to regulate the Statute of Limitations accordingly - ten years? - twelve years? - fifteen years? Finally, if cost is the crux of the situation, it might be very appropriate to consider what the difference might be between this type of an expenditure and outlays in the form of payments made by the Department of Public Welfare, as far as dollars and cents is concerned. An occupational disease payment does more for the soul than an outright Department of Public Welfare benefit. Ask the man that gets one! Today, the Department of Public Welfare pushes applicants to file under the Occupational Disease Act when, in their perfunctory review of a case, an individual might appear to be eligible. When a subsequent award is forthcoming from an occupational disease case, the Department of Public Welfare gets a refund and the employee is then taken from its rolls.

Two cardinal points must be considered at all times:

(1) A man is just as totally disabled and just as handicapped and economically depressed and economically incompetent if he becomes totally disabled due to the disease within one year, - three years, - five years, - ten years, - or twelve years. We have a daily reminder in our work by the parade of men who, now totally disabled due to anthracosilicosis, are denied the benefits of the Act simply because the insidious disease "took a longer period to catch up with them"; and

(2) Money appropriated by the Commonwealth of Pennsylvania to finance Section 301 (g) is, in reality, a subsidy to coal companies. This statement is not meant to be argumentative. It is just a fact of life and a fact of compensation reality.

In conclusion, it is respectfully submitted that the Statute of Limitations should be eliminated and related Sections (Section 301 (d) and others) should be appropriately amended. If the cost factor is so overwhelming (and cannot be denied)--then the Statute of Limitations should be extended to at least ten to twelve years. Graphs and statistics shown today are accurate, but much more publicity should be given (in all fairness) - as to the "raision d'etre". The graphs re expenditures, shown at this meeting, would, at first blush, appear to be enough to give any common servant a heart attack! However, explained in the light of reasons why,--the occupational disease picture is not the ogre that it might appear to be at first blush, from the viewpoint of cost to the commonwealth.

Thank you one and all for your kind attention.

THE FOUR YEAR STATUTE OF LIMITATIONS

George W. Katter, M.D., Internist
Chief of Medicine, Mercy Hospital, Johnstown

It is both a privilege and a pleasure for me to have been invited to address this distinguished group this afternoon. When Dr. Lieben asked me to speak at this session, I had some misgivings. However, after searching my files, and dusting off my memory, I found that there were indeed many cases of uncompensated totally disabling silicosis which have been under my care in the past and at the present. As recently as yesterday I discovered another case.

In order to give you a greater understanding of the problem, and to establish a few ground rules, I feel that it is important to familiarize you with some of the basics of silicosis.

The term silicosis is a commonly used term which refers to the condition of the lungs in men exposed to sand dust or rock dust in the mines, or silica fumes in foundries or refractories. Other terms used are coal workers' pneumoconiosis, or anthraco-silicosis. On entering into the lungs of dust particles, the body starts its defense mechanism working, and establishes fibrous strands around the foreign particles. Depending on several factors, such as concentration of dust, amount of exposure and body resistance, the process of fibrosis takes place. Although I have no scientific proof, I am convinced that an additional factor of individual sensitivity enters into the process. Given two men with equal exposure, one develops severe silicosis, the other--not so severe.

The first symptoms are cough and shortness of breath. The severity of these symptoms is determined by the extent of silicosis. Obstruction of the bronchial tubes develops and the patient's breathing is further embarrassed and his cough further aggravated. As time goes on, regardless of whether or not the man continues in the mines, the process continues. If he happens to be a smoker, the process takes a more rapid course.

As the process continues, other ill effects make their appearance. Asthmatic wheezes appear, the bronchitis becomes much worse, and a very severe condition of bronchiectasis results in which patients may cough up large amounts of purulent sputum as well as blood.

Tuberculosis is a favorite complication of this condition, and after a few years, the heart becomes affected with what is called cor pulmonale. In this condition the right side of the heart undergoes enlargement due to constant pumping against pressure in the lungs. There is really no satisfactory treatment for this condition.

When a worker develops silicosis, he is not inclined to seek medical aid early because he has no complaints. He may be found to have the disease by a routine x-ray such as by a mobile unit, or in conjunction with studies of other conditions. In that the symptoms are not severe, the patient goes on working in his same environment. He continues to work, and the changes in his lungs become more marked. The fine micro-nodular densities become confluent, and eventually they coalesce. Meanwhile cough develops, shortness of breath becomes apparent, and his work becomes more and more difficult to perform. By this time it is advisable for the worker to leave the mines and seek other employment.

Here, several factors are at play to obstruct any plans he may have.

After so many years in the mine, he is a permanent fixture. He may have several children depending on him. He may own or nearly own his home which is not marketable in his small depressed area. He feels inadequate in that he knows no other trade, and due to his usual minimum of education, he is not a candidate for rehabilitation along other lines. If he goes to the extreme and springs his trap, he is rebuffed when seeking other employment. As soon as a prospective employer gets an x-ray, chances of employment melt like snow under the sun. It matters not whether the employee is capable physically, if he has even minimal disease, he cannot be employed.

Another unfortunate situation is that of the man caught in a layoff, not having compensible silicosis. Faced with the impossibility of getting another job, he has nowhere to turn but to the DPA where his and his family's adjustment of times is very difficult. Eventually he will inevitably fall victim to the ravages of this disease, and his symptoms may develop after the statute of limitations has run its course. Further economic and physical stress ensues.

It has been my experience that several circumstances determine the success or failure of a patient seeking compensation.

1. Deliberate withholding of information by physicians whose interests are not primarily those of the patient.

2. Failure of examinations for whatever reason.

3. Inability of the patient to understand the implications of x-ray findings, even when explained.

4. Unavailability of medical care prior to the establishment of the UMW Welfare Fund.

5. Involvement in other work after leaving the mines while the disease progresses.

6. Variation of interpretation of findings by different physicians.

To give you more concrete examples, I cite the following cases:

1. J. M. – Age 80 - Retired at age 65.

   Last worked in 1949.
   Never knew he had silicosis.
   First knowledge 1962.
   Symptoms began shortly after retirement.

2. J. B. – Age 74 - Retired at age 60.

   Last worked in 1952.
   Has dyspnea and cough.
   Was told he didn't have enough.
   First knowledge before he retired.
   Symptoms started before retirement.
   Quit work because he couldn't go on.

3. T. M. – Age 73.

   Last worked 1952.
   First knowledge May 1964 under my care.
   No previous chest x-rays.
   Breath became short before he quit working.

4. L. E. – Age 49.

   Last worked September 19, 1964.
   Told he had dust in his lungs in 1957. X-rays subsequently and as recently as summer of 1964. Was told his lungs were no worse than on previous exams. Patient couldn't believe it because he was getting worse. No previous advice to quit working.

5. T. R. – Age 73

   32½ years in the mines.
   Quit work in 1953.
   X-ray 1959 first knowledge of silicosis.
   Now under treatment for cardiovascular disease.
   X-ray of chest.
   Pulmonary ventilation studies showed severe pulmonary disease.

6. E. H. – Age 57

   Began in refractories in 1923, continued to early 30's. Then did some farm work, highway work and state park work to 1943. Died August 20, 1964. Autopsy revealed advanced silicosis.

In 5 of 6 cases the statute of limitations had expired. There are countless other cases in my own files.

What conclusions can be drawn from the foregoing discussion? I have tried to emphasize the point that there should really be no time limitation imposed on a patient seeking compensation benefits for silicosis.

I have tried to point out several extenuating factors involved in the line of obstacles to a man seeking silicosis compensation. From the medical standpoint, the insidious nature of the disease is probably the most important point. The delay in development of symptoms has an important bearing on this problem. More often than not, a man may quit work because of retirement age, or may be laid off, without the knowledge that he has silicosis. As he grows older, the complications of emphysema, chronic bronchitis, asthma and cor pulmonale begin to appear. It may take several years for these symptoms to appear, and to cause debility. At this point it may be more than 4 years since the miner last worked. Automatically therefore, he is ineligible for compensation. Therefore, the lag between the development of silicosis and the development of pulmonary or cardiac symptoms should be taken into consideration.

The human factor involving the physician sometimes comes into play. There no doubt is partiality on one side of the fence or other. This factor is a bi-directional one. The problem is not so obvious today as it was years ago. The so-called company doctor minimized or denied completely the presence of silicosis. Diagnoses such as "a little dust on your lungs" may have meant anything from a few micronodular densities to bilateral, massive coalescent lesions with emphysema and cor pulmonale. Frequently the patient remained under the jurisdiction of a partial company doctor, and was doomed for life. If he got out of the ghetto to be seen by an impartial physician, it was frequently too late. This is not to incriminate all company doctors, nor to free of culpability those physicians whose interest is solely that of the miner. On the other side of the coin, many attempts have met with success in procuring compensation benefits for those not really having sufficient disease.

To avoid the difficulty of partial physicians, attorneys and political appointees, an impartial board consisting of qualified physicians and attorneys should review compensation cases, and make determinations of disability without regard to political or pecuniary influences. Broadening the time span between retirement and application for benefits, thus allowing for the delay in development of symptoms, should be considered.

Periodic health examinations and particularly x-ray examinations should be mandatory before, during and after employment.

I hope that this brief resume will serve to familiarize this audience with some of the medical problems encountered in the management of anthraco-silicosis. In particular I hope that I have stressed the significance of the unrealistic provisions of the present statute of limitations. It is hoped that your familiarity with these problems will provoke your interest. It is hoped further that in some small way this paper will contribute to the greater understanding and solution of this serious public health problem.

Thank you.

REPORT OF THE CHAIRMAN

Carl C. Kuehn, M.D., Director
Bureau of Field Services
Department of Health, Harrisburg

The first paper, by Dr. Roy Greening, Radiologist, Jefferson Medical College Hospital, discussed the value of the periodic chest x-ray in the control of pneumoconiosis.

Dr. Greening pointed out that the chest x-ray is the single best tool to diagnose heart and lung disease. The new International Classification of Pneumoconiosis is tailored to silicosis and very satisfactory. It is being extended to include other pneumoconioses, beginning with asbestosis.

As a result of post mortem x-ray studies it has been determined that solitary nodules greater than 1 millimeter in size can be seen on chest x-ray. Multiple diffuse nodules even smaller can be seen.

A number of films were shown to illustrate that in some cases extensive pulmonary nodularity may exist without symptoms or symptoms may precede positive x-ray findings. Therefore, other studies in conjunction with the chest x-ray are most useful in evaluating a case.

One of the most difficult differential diagnoses is between conglomerate silicotic masses and lung cancer. This problem frequently comes up in men with 20 or more years exposure in the mines. Research is presently being conducted on contrast pulmonary arteriography in such cases.

Another pathological finding in advanced pneumoconiosis is the existence of large plastic lesions. Recent investigations show that these are ischemic lesions from slow arterial occlusion. The end result after a number of years is large emphysematous blebs.

The second paper on clinical aspects of pneumoconiosis was given by Dr. Peter Theodos, Chest Specialist, Jefferson Medical College Hospital. Dr. Theodos pointed out that his Silicosis Service was in the 16th year of study and treatment of pneumoconiosis under the auspices of the Anthracite Health and Welfare Program. They have studied 2376 miners, nearly all hard coal miners, or about 1% of the hard coal miners in Pennsylvania during this period. About half of these patients have died.

The classification of pneumoconiosis is based on the size of the nodules present on x-ray:

Stage I ---------- Nodules <2 mm.

Stage II ---------- Nodules 2-5 mm.

Stage III ---------- Nodules >5 mm.

Many miners with adequate exposure have negative, borderline (increased lung markings), or atypical (linear fibrosis without nodulation) x-rays. More advanced cases of Stage III show large conglomerate nodules, plastic lesions, and emphysema.

Lung biopsy has been of great value in diagnosing borderline cases. It is estimated that about 10-15% of these pneumoconioses cases continue to increase in severity after removal from dust exposure.

The basic physiological impairment is obstructed ventilation. The degree of impairment is more related to emphysema than fibrosis or granulation. Pulmonary function tests are the best means of determining disability.

Tuberculosis is the most significant complication and the commonest cause of cavitation. About 15% of this group of cases developed positive sputum cultures for tuberculosis.

Sterile cavities result from ischemic necrosis. The end result is emphysema.

Carcinoma of the lung developed in 1.8% of the cases, which is a higher incidence than in general population.

At present there is need for pre-employment x-rays, periodic x-rays during employment, and improvement of the compensation laws to provide more realistic and equitable adjudication of claims.

The third paper, by J. B. Holtzapple, Manager of Safety and Training, Blaw-Knox Company, concerned management's viewpoint of a periodic x-ray program. He indicated that advent of the Workmen's Compensation Laws for Occupational Disease caused his company to initiate pre-employment and periodic chest x-ray of employees. With his company's number of employees and the use the machine would have in x-raying injuries, his company decided to do its own x-raying.

Initially the employees with positive x-ray findings were hard to evaluate because no provision had been made for pre-employment x-rays and they had often worked at other dusty jobs prior to employment.

He has also noted that of a number of employees with the same apparent silica exposure for years, only a few get silicosis. And, it is not apparent which ones will.

The periodic x-ray program has lead this company to take many steps to reduce pneumoconiosis: first, a reduction in worker exposure by respirator use; then, wet-down cleaning, and exhaust ventilation procedures to reduce silica dust exposure. Also, aluminum inhalation by the workers was attempted as a means to prevent silicosis.

In addition, a number of non-occupational chest diseases have been first found in the company x-ray program, leading to life-saving medical procedures.

The periodic x-ray program has saved and prolonged many lives. Therefore, the management of this company regards it highly, since they feel even one life saved more than justified the cost.

The fourth paper, by H. K. Abrams, M.D., Union Health Service, Chicago, concerned the union's view of periodic x-ray examination of employees. He stated that one of the principal union interests at present is employee health programs, so that they are interested in periodic x-ray examination of employees and more.

Management, unions, and all parties concerned are interested in employee health programs. Differences do arise over economics, however. For example, who pays for the program.

Differences also arise over who the medical information on workers is being obtained for. Unions feel that the information is for the worker or his doctor. They also object when medical information is used to deny a worker employment or remove him from employment.

The ideal is to wipe out all occupational disease by removing all industrial hazard. This may never be fully attained.

In the meantime, companies should agree to make available all medical information they have to the employee or his designee on written request. An impartial medical board might also be established to provide medical information to all parties concerned; and to evaluate medical data for all parties concerned.

Some day this country, like Sweden, may compensate occupational and non-occupational disability alike.

Prepaid group practice medical plans offer comprehensive preventive medical programs, as well as treatment, to employees. These plans presently exclude occupational health services because of the separation of occupational and non-occupational health services, but the management of these plans would like to do so.

The fifth paper, by F. R. Barnako, Manager of Compensation, Bethlehem Steel Corporation, concerned management's view on whether periodic x-ray should be compulsory or voluntary.

Mr. Barnako stated that because disability in dusty trades may develop in 1 - 20 years, periodic chest x-ray of workers is most useful to monitor workers. It helps identify work areas, individual susceptibility to pneumoconiosis, progress of pneumoconiosis and other disease.

However, the occupational history, physical examination, and pulmonary function tests such as maximum breathing capacity, vital capacity, timed vital capacity, and arterial oxygen saturation are also needed to evaluate pneumoconiosis in the individual.

He pointed out that a mandatory x-ray program is inflexible. The ideal program is a voluntary flexible program, run by a qualified physician, who determines the number, type, and frequency of x-ray and does other studies, dependent on the worker's exposure and condition, with worker consent.

But, the very best approach is to reduce the dust at its source, and provide necessary personal protective equipment.

He raised serious question about the proposed Pennsylvania Pneumoconiosis Prevention Act* largely on the basis of the compulsory examination of workers.

The sixth paper concerned another union view on a periodic chest x-ray program by Joseph Yablonski, President, District No. 5, United Mine Workers of America. Mr. Yablonski pointed out that automation had increased the amount of dust in mines. The first order of business should be a better program to reduce all hazards in the mine, including dust and explosive gases.

Next should come a liberal compensation, medical payment, and rehabilitation program for the miners. Then periodic medical examination, which may lead to findings requiring compensation, medical expenses, and rehabilitation can be considered. However, employment should not be affected by medical findings on conditions not aggravated by the employment.

Although pneumoconiosis is a problem miners have many problems. It was recommended that there be a permanent committee from all concerned to study and present a comprehensive program to the legislature to cover all problems concerning the safety of the miners.

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* In the discussion which followed Dr. Lieben pointed out that the "Pneumoconiosis Prevention Act" was only drawn up for the purpose of stimulating discussion and was not meant to be introduced into the legislature in its present form.

REPORT OF THE CHAIRMAN

Carl C. Kuehn, M.D., Director
Bureau of Field Services
Department of Health, Harrisburg

In the first paper, Dr. William C. Stewart, Chairman of the West Virginia Silicosis Medical Board, discussed the technical difficulties involved in determining partial disability.

From 1936 to 1961 the board was only required to determine whether no disability, partial disability, or total and permanent disability exists. Since then, the percent of disability must be determined in partial disability.

From March 1962 to October 1964, 1000 claims were processed, of which 489 were partial disability. To determine the percent of disability in these cases, detailed occupational and non-occupational medical history, physical examination including an exercise test, chest x-ray, and pulmonary function tests were required.

The pulmonary function tests have been most useful in determining the percent of disability. The timed vital capacity, the maximum breathing capacity, and the walking ventilation test, all done three times, have proved the most valuable of the pulmonary function tests.

On the basis of experience to date, it appears that partial disability can be determined in about 10 percent of increments from 15 to 60% of disability. If any partial disability is found, it has been classified at least 15%. If disability over 60% is found, it has been called total disability.

The attempt to classify partial disability has been reasonably successful to date, and continued improvements are being made in the program.

The second paper by Mr. James Robinson, an attorney from Clarksburg, West Virginia, concerned management's view on partial compensation. He pointed out that West Virginia compensates on the basis of loss of earning. The employer is responsible for compensating all worker disability incurred from employment. The Silicosis Law covers only one aspect of this industrial compensation -- silicosis and tuberculosis.

Under the law, the employee must have been exposed to silica at least two years out of the last ten. Payment is prorated among all the employers in which exposure has occurred, according to time of employment.

Prior to 1961 a fixed and final lump sum payment was made to the employee applicant, the sum depended upon the amount of his disability. Under the new law additional payment may be awarded if the percent of disability subsequently increases.

This speaker prefers the older law in which partial disability was not graded, and subsequent additional awards could not be made, other than for disability from other cause.

He pointed out that withdrawal from the job may not stop the progress of the disease; that the effect of the exposure is not uniform in all individuals; and that doctors by nature are sympathetic and inclined to rate disability high.

He further stated that a fixed sum payment encourages workers to take recommended precautions to avoid the disease, and emphasized that the percent of disability is hard to determine.

The new law may overburden industry economically.

The third paper, Mr. David T. Kennedy, Attorney from Beckley, West Virginia, concerned the claimant's view on partial compensation. He pointed out that the present law is better for the claimant. It offers him the opportunity to file for disability and obtain subsequent additional awards if the disability does increase.

The fear that the number of total and permanent disability awards under the new law would increase has not materialized. Furthermore, the group of individuals receiving such awards is a diminishing one, since their average life expectancy is six years.

There are remaining problems in spite of the new law. New employees must meet the employer's criteria for employment; and furloughed employees are in the same category as the new employee. An employer is unlikely to hire or rehire a man with silicosis.

In another state, Virginia, the man's disability is classified as total and permanent if he is removed from employment.

The present law is a step in the right direction to give the workers what is coming to them.

REPORT OF THE CHAIRMAN

Leon Cander, M.D., Associate Professor of Medicine
Head, Section of Chest Diseases
Hahnemann Medical College & Hospital, Philadelphia

Having had the temerity to accept the job of arranging and chairing the Special Session on Disability Evaluation, I now have the formidable task of summarizing the deliberations of that Session for you.

Recognizing that the present system of disability evaluation is not standardized and is all too often inadequate, the participants of that Session assumed as their major responsibility the design of an effective, standard method of disability evaluation. To accomplish this aim, certain innovations and changes in the administration of the presently utilized evaluation techniques were considered to be essential. This report consists fundamentally of the proposed plan for disability evaluation and the attendant recommendations.

First, let me assure this audience that your chairman is aware of the fact that the problem under discussion has broad social, economic and psychologic as well as medical implications. Therefore a socially responsible, truly comprehensive program for disabled coal workers will include not only disability evaluation and compensation, but also medical and vocational rehabilitation. Such a program would of necessity require all of the resources of the community.

Second, since scientific data are not available in all areas, any program implemented in the near future must be sufficiently flexible to permit changes to take place without major legislative overhaul as new data become available.

Against this background let us consider the series of proposals emanating from the Special Session on Disability Evaluation:

1. Since there is a large body of evidence from Great Britain and from recent studies by the USPHS in this country that inhaled carbon particles containing little or no free silica may produce disabling pneumoconiosis, it is recommended that the term anthraco-silicosis be abandoned in favor of the more inclusive term "Coal Workers' Pneumoconiosis". When considering disability evaluation, we shall define Coal Workers' Pneumoconiosis as a chronic pulmonary disease occurring in an individual with a history of occupational exposure, evidence of anatomic change and associated pulmonary disability.

2. Since there is a great deal of evidence to show that pulmonary disability may occur years after the development of the structural changes in the lungs of men with Coal Workers' Pneumoconiosis, it is recommended the four year statute of limitation in the State's Occupational Disease Act in the determination of a coal worker's eligibility for disability compensation be eliminated.

3. Since the relationship between the x-ray stage of Coal Workers' Pneumoconiosis and the degree of disability is frequently poor or non-existent, it is recommended that less emphasis be placed on the x-ray stage of the disease and more emphasis be placed on functional evaluation in disability determination.

4. Though admittedly difficult, it is recommended that some effort to quantitate the degree of disability be made in every case of disability evaluation. This would permit the establishment of a scale of compensation in line with the percentage of disability of the coal worker. This is deemed to be a far more realistic approach than the present system of allowing compensation only when the worker is considered to be totally disabled.

The most objective assessment of the degree of bronchial obstruction presently available is the measurement of the airway resistance. Wherever available, the participants of the Session recommend the objective measure of the airway resistance as their first choice among pulmonary function tests to assess bronchial obstruction.

Recognizing that the information obtained in the above recommended minimum examination may be inadequate in a given situation, it is recommended that a more complete pulmonary function survey be done in any case where there is a significant abnormality in any one of the five aspects of the minimum examination. It is recommended that such a survey include:

a. A test which assesses the distribution of alveolar ventilation. The single breath nitrogen test was suggested for this measurement.

b. The measurement of the pulmonary diffusing capacity.

c. An exercise study wherein the ventilation equivalent is measured.

8. It has been demonstrated that the prolonged inhalation of coal dust will produce a distinct, disabling disease which however, is often physiologically indistinguishable from chronic emphysema. Despite the fact that the two separate entities exist, some confusion has been created by the fact that the two diseases are physiologically similar.

The participants of the Session again emphasize that coal dust inhalation can produce a disabling disease. The Session also notes that a history of exposure, evidence of the presence of Coal Workers' Pneumoconiosis and the documentation of physical incapacity establish the presence of a compensable disease.

9. Finally, the participants of the Session recommend that the State establish and maintain screening centers in certain key geographic locales where the appropriate studies referred to under (7) may be done. In addition, these centers will be capable of performing pre-employment and annual examinations in any industry with a dust hazard.

The establishment of such centers does not preclude the use of presently available facilities in the Medical Schools and Hospitals. However, it should be noted that the existing facilities are already committed in many areas and would not be able to handle any significant number of men in a disability evaluation program.

Let me conclude this report by quoting Ramazzini, the Father of Occupational Medicine who, about 250 years ago said:

"Medicine like jurisprudence, should make a contribution to the well-being of workers and see to it that, so far as possible, they should exercise their callings without harm."

I hope those of us who participated in this Session discharged our social responsibility by contributing in a small way to the health and welfare of the people of the State of Pennsylvania.

5. The Session gave a wholehearted endorsement to Dr. Eugene Robin's suggestion concerning the creation of a State Board of Pneumoconiosis to oversee and coordinate the various programs of pneumoconiosis prevention, control, research, disability evaluation and rehabilitation. Such a Board would be made of distinguished biologists, engineers, physicians and appropriate representatives of the State Government.

6. Since the exact mode of onset and many aspects of the natural history of Coal Workers' Pneumoconiosis are still largely unknown, it is recommended that the State undertake the support of a program of basic and clinical research in these areas. The scientific data obtained from such research would lead to more effective control of the disease and more objective disability evaluation. Thus, a modest research investment could lead to future untold savings in human life and compensation payments. It is suggested that in addition to research conducted in its own laboratories, the State make research grants available on a competitive basis to the various universities, colleges and independent research institutes capable of conducting research in this area. It is further suggested that the research grants be selected for award by extramural study committees appointed by the State Board of Pneumoconiosis in a manner similar to that utilized by the National Institutes of Health in awarding extramural research grants. In this way advantage will be taken of Pennsylvania's wealth of scientific and technical manpower in acquiring the information necessary to control and (hopefully) eradicate Coal Workers' Pneumoconiosis.

7. Over the past two decades there has been an unprecedented growth of knowledge of how the lungs function in health and disease. Many of the techniques utilized at first in research studies have become standardized and are presently employed as clinical pulmonary function tests in assessing the presence and extent of pulmonary insufficiency. A large number of the most recent pulmonary function tests are objective, requiring no patient cooperation. These latter tests are obviously the most desirable in assessing patients.

Knowledge of pulmonary function is as yet imperfect and the correlation between the degree of abnormal lung function as shown by pulmonary function testing and the degree of physical disability is not a precise one. Yet, there is sufficient experience at present to utilize the information gained from these tests to enormous advantage in assessing disability. Therefore, it is suggested that more emphasis and reliance be placed on pulmonary function testing in the disability evaluation of coal workers.

Parenthetically, it might be added that if the State undertakes the suggested program of research, then the information necessary for more precise interpretation of the pulmonary function tests will be forthcoming, thereby facilitating disability evaluation in men with Coal Workers' Pneumoconiosis.

Against this background, the participants of the Session suggest the following as the minimum information for disability evaluation:

a. A complete medical history with emphasis on occupational exposure and the degree of breathlessness.

b. A complete physical examination.

c. Chest x-ray – standard PA film with other views as deemed necessary.

d. A standard 12 lead electrocardiogram and where available a vectorcardiogram. Recent studies suggest that the vectorcardiogram correlates better with the presence of chronic lung disease and heart disease secondary to lung disease than the standard electrocardiogram.

e. Since the available evidence indicates that some degree of bronchial obstruction is an invariable concomitant of Coal Workers' Pneumoconiosis, it is deemed necessary that at least one pulmonary function test which assesses the degree of bronchial obstruction be included as part of the initial examination for disability determination. Although the participants of the Session did not endorse any specific test, they did favor the use of a test which is based upon quantitative analysis of the single forced expirogram. Such tests include the Maximal Expiratory Flow Rate, the Mid-Maximal Expiratory Flow Rate and the Forced Expiratory Volume expired in 0.75 seconds. These tests were preferable to the Maximal Breathing Capacity because they are less fatiguing, easily repeatable and require less patient cooperation than the Maximal Breathing Capacity.

Report of Committee for Special Session on Dust Control

Chairman: J. R. Garvey, President
Bituminous Coal Research, Inc., Monroeville

Co-chairman: K. M. Mason, Director
Bureau of Environmental Health
Department of Health, Harrisburg

At the Dust Control Session of the Conference held yesterday the many important aspects of the control of dust in the underground coal mines of the Commonwealth were discussed. Covered in the discussion were (1) methods of sampling air borne dust, (2) the analytical techniques used to evaluate the samples, and (3) the dust control procedures, especially at or near the face where the major portions of the dust are produced. The need for improved methods and procedures in all three areas, sampling, analysis, and control was recognized.

Participating at the special session were those groups most concerned with dust conditions in both bituminous and anthracite mines. These included the Commonwealth's Department of Mines and Mineral Industries which is charged through the Pennsylvania mining laws with providing for the health and safety of employees working in the coal fields and the Department of Health which is charged with the protection of the health of all the people of the Commonwealth. These two departments have combined their resources in a cooperative study of coal mine dust problems in Pennsylvania.

Also represented were two agencies of the federal government interested in the problem nationally. These included the Bureau of Mines which is concerned with evaluation of control techniques and the Public Health Service which is concerned with evaluation of the effects of dust exposure on the miner. In the discussions, the Commonwealth and federal government groups were joined by representatives of the United Mine Workers of America, the commercial and captive producers of coal in Pennsylvania and the manufacturers of mining equipment all of whom are seeking the development of better means for protecting the health and safety of Pennsylvania coal miners through more knowledge of the causes and control of air borne dust.

Although the ultimate objective of any safety and health program is the elimination of a specific hazard, the program must of necessity start with a definition of the nature and scope of the hazard and the contributory elements. In the defining of the air borne dust problem as well as in evaluating the effectiveness of control methods nothing is of greater importance than the dust sampling and analytical techniques which are utilized.

The Commonwealth's Departments of Mines and Health have since 1960 been conducting a cooperative sampling and analysis study. The purpose of this study is two-fold; first to immediately effect dust control and second, to obtain environmental data for a long range epidemiological study. Immediate dust control is effected whenever a concentration of dust exceeds the numerical value of the American Conference of Governmental Industrial Hygienists threshold limit. It is of interest to note that in studies made to date only about 7% of the time-weighted exposures have exceeded the threshold limit values.

Dust sampling in Pennsylvania coal mines is carried out by four men of the Department of Mines and Mineral Industires. Breathing zone samples are collected by the midget impinger for 5 minutes out of each 15 minutes for the shift. Membrane filter samples are also collected in the breathing zone. The former samples are used to determine dust counts using the U. S. Bureau of Mines microprojector technique while samples from the latter sampling are used for particle size analysis. In addition, settled dust samples are collected and submitted to the Department of Health for chemical analysis.

The epidemiological aspect of the Commonwealth's study is carried out by the Department of Health. Environmental measurements are compared with medical study of the miners including chest x-ray, timed vital capacity and occupational histories. In order to integrate the medical data with the environmental measurements obtained in the coal mines, a close relationship between the two departments must be maintained.

In addition to this program which is being pursued by the two departments of the Commonwealth, every organization represented at the session yesterday is involved directly or indirectly in sampling and analysis studies pertaining to air borne coal dust. From the discussions it was apparent that current methods of sampling and analyzing dust leave much to be desired. For example, the method used to determine the chemical composition utilizes settled dust samples, whereas the composition of air borne dust may be substantially different. For another example, the present method of assessment is based on a dust concentration expressed as the number of dust particles per cubic foot of air. Recent studies of the dust problem associated with the production of coal indicate that a weight basis, with concentrations expressed as milligrams of dust per cubic meter of air, might better define the degree of exposure hazard. The weight basis has merit when large particles, those which are too big to enter the deeper recesses of the lung, are removed from the sample.

Acceptable standards for sampling and analysis are essential to the development of improved control methods.

Methods for the control of air borne dust in coal mines have been studied extensively in the mines of Pennsylvania, of other coal producing areas of the U. S. and in many foreign countries – notably Great Britain. Many of you who were here at the Monday session of the Conference heard Dr. John Rogan, Medical Director of the National Coal Board discuss their work. All such studies both here and abroad have been intensified in recent years because of the mechanization of coal mining operations, especially at the face.

As Dr. Charmbury pointed out at the Monday session the very nature of coal mining methods produces dust. Dust control is not however, a problem peculiar to coal mining; many other industrial processes have to cope with this handicap. But the confined areas in which the dust must be controlled combined with the need for ventilating air, especially in gaseous mines, makes the coal mining dust problem a most difficult one to overcome.

But substantial progress has been made, especially in Pennsylvania. As one of our session speakers pointed out a recent Bureau of Mines study showed the Commonwealth mines to have more effective dust control than the U. S. average.

But improvement is still being sought and at the session yesterday various ideas, some old and some new, for achieving even better dust control methods were discussed. These can best be summarized by reviewing them briefly as part of what might be considered the four objectives of the overall industry and government dust control effort.

First, to so design, maintain and use the mining machine so the production of fine-sized particles is minimized. Much progress has been made in this direction through improved machine design. Better cutting bits which stay sharp longer and thus produce less fines, and more judicious placement of the bits to direct the particles downward where they will be less likely to become air borne, have been steps toward better dust control through machine design. A recent study indicates that larger and fewer bits on a machine may further reduce the formation of particles which can become air borne.

The second objective is to capture the small particles before they can become air borne. The most commonly used method is by water spraying. Extensive studies in the past, and current work, are showing the way to better spray systems and better nozzles which enable the direction of a minimum amount of water at the right place to do the most good. The mention of water sprays inevitably leads to discussions of additives to the water such as wetting agents. This is apparently an area requiring further investigation since the presentations made at the session indicated advantages under some conditions but not under others.

A more recently tried method for keeping dust particles from becoming air borne is the use of foam. This has been demonstrated to be a most effective means for capturing fine coal particles but many problems such as dispersion of the foam after it is used, toxicity of the foam and proper methods of application must be solved before practical utilization of the idea can be made.

The third objective for a dust control system is to provide for removal of the settled or captured dust from the working area. And here we must consider coal mine ventilation – especially bituminous coal mines where the primary purpose of ventilation is to dilute and carry away the methane which is released from the coal face.

The usual method for ventilating is by conducting air to the working face, either by tubing or by brattice curtains. This adequately controls the gas problem and provides air to the operator, but it does not control the dust problem and, in some instances aggravates it. For dust control, the better method is to exhaust the air from the face by tubing or brattice placed as close to the face as possible. However, this technique can lead to gas accumulation because of a lack of diffusion. The combination of gas control and dust control has been used successfully in some instances by exhaust ventilation from the face coupled with the use of a diffusing fan mounted on the machine.

Some investigators have concluded that a proper system of ventilation combined with water sprays is the most effective method of dust control.

Another suggested means for clearing air borne dust from a coal mining face is by directing the dust laden air into a special dust collector before it reaches areas where it constitutes a health or explosion hazard. The effectiveness of such collectors has been shown but their size, lack of mobility and complexity of use have in their present state of development made their use impractical.

The fourth and final objective for a dust control system is elimination of the health and safety hazard without the imposition of intolerable technical and economic burdens on the coal mining process. This may be the most difficult objective to achieve but the goal justifies an all out effort. Substantial gains have been achieved and further progress toward an effective, practical, low-cost method will be made.

Those were the subjects discussed in detail at the session on dust control. It is apparent that coal producers, labor, government and equipment manufacturers all recognize that a problem exists and there was presented ample evidence that progress in dust control in coal mines has been made. But it is also apparent that the lack of adequate basic knowledge on what coal dust levels constitute a hazard and how to effectively sample and analyze air borne dust is restricting efforts at improved control. The obtaining of the needed basic data will not be simple and there are no short cuts. But the Committee believes the job can be done and recommends that the momentum established by this Conference be maintained. To accomplish this it is recommended that the Governor appoint a committee consisting of three representatives of the U.M.W.A., two representatives of the bituminous coal operators, one representative of the anthracite operators, one representative of the mining machinery manufacturers, the Secretary of Mines and Mineral Industries, the Secretary of Health and one public representative. The function of this committee will be to study and evaluate the discussions of this Conference and recommend action on the suppression of dust in the coal mines of Pennsylvania. If this suggestion can be favorably considered, it is recommended that the committee on arrangements for this Special Session On Dust Control be asked to designate the names of the U.M.W.A. representatives and the operator representatives of the new committee.

REPORT OF THE CHAIRMAN

Charles L. Eby, Director
Bureau of Vocational Rehabilitation
Department of Labor and Industry

In the Special Session on Rehabilitation, Dr. Edward M. Sivick, Medical Administrator of the Pennsylvania Bureau of Vocational Rehabilitation and Medical Director of the Disability Determination Unit of the Social Security Administration, outlined the medical factors of eligibility and medical services available from the Federal-State program of vocational rehabilitation.

This was followed by a presentation from Tom Williams, Wilkes-Barre District Administrator, in which he elaborated on the vocational factors. The first two presentations established the role of vocational rehabilitation and set the stage for the next two presentations.

Mr. Thomas I. Fulton, Rehabilitation Administrator of the United Mine Workers of America, Welfare and Retirement Fund, Johnstown, Pennsylvania, presented the needs of a person with chest disabilities in reference to the Pennsylvania Occupational Disease Act. He emphasized the following limitations and inadequacies of the Act:

1. There was no provision for partial or temporary benefits for pneumoconiosis cases which would support the rehabilitation process.

2. The limitations of the period of medical services and the maximum medical expenditures is unfounded.

3. Mr. Fulton emphasized that rehabilitation brings out the best in an individual and the best in a democratic society.

4. He strongly recommended that a diagnosis of simple pneumoconiosis should be evidence that the individual is entitled to rehabilitation services including medical care, retraining, treatment, and other supportative services.

5. The benefits allowed for the chest disease cases are significantly different than for workers who suffer from industrially incurred accidents.

6. The Commonwealth not the industry is carrying the burden for most occupationally incurred lung diseases while the employer or his insurance carrier is legally responsible for industrial accidents.

7. In 15 years the UMWA referred 4,600 disabled miners and dependents to the Pennsylvania Bureau of Vocational Rehabilitation. 1,900 have been reported to be successfully rehabilitated including employment placement. About 12% of the successes were chest cases. There could have been a greater number served if the financial standards of the Bureau of Vocational Rehabilitation would be revised upward.

8. Whether by design or accident our present occupational disease law seems to pre-condition men to permanent disability and permanent poverty.

One of the outstanding presentations of the entire conference was made by Dr. Joseph E. Cowle who is Medical Director of the Occupational Chest Unit of the Industrial Hygiene Branch of the Ontario Department of Health. Dr. Cowle emphasized the Canadian program of removing the hazard. Since other reports were directly assigned to this topic this phase is being omitted in this report. Dr. Cowle's paper elaborated on pre-employment and annual examinations. He illustrated the rehabilitations started immediately following detection. Dr. Cowle is making his paper available for the permanent records of the conference.

The discussion recommended the following for consideration:

1. It is recommended that this conference be the beginning of an assault on pneumoconiosis and not the end.

2. An Evaluation Committee be appointed to review the material presented at the conference and a summary be mailed to the conference participants. It is hoped that such a summary would call for a program of further action. This Evaluation Committee should be composed of representatives from at least the Department of Health, Department of Mines, and the Department of Labor and Industry.

3. It is proposed for consideration that at least $500,000 of the estimated $21,000,000 for the fiscal year ending June 30, 1966, be assigned to the Bureau of Vocational Rehabilitation. The assigned state funds would earn an additional $700,000 of Federal funds under the National Vocational Rehabilitation Act administered by the Vocational Rehabilitation Administration.

4. The $1,200,000 could be used to establish clinics or centers to do the following:

   A. Pre-employment and annual examinations.

   B. Medical treatment and care would follow the early detection.

   C. These examinations could be used for disability determination by the Bureau of Workmen's Compensation.

   D. Vocational rehabilitation services would be provided to assist in the re-assignment of the disabled worker within the industry or employment opportunities could be developed that would eliminate any further exposure.

5. The clinics or centers would be directed by an administrative committee composed of representatives from theDepartmentsof Health, Mines, and Labor and Industry. This committee could be selected by the Council of Human Services for appointment by the Governor. To muster all available resources an Advisory Committee should be appointed with members representing the medical profession, medical facilities, research, industry, labor, and others that would be knowledgeable or directly involved.

6. These clinics or centers should be located in existing medical facilities conveniently located in the hard and soft coal fields.

7. The staff of these clinics should be composed of a team of at least one medical director, a laboratory technician, a psychologist, a vocational counselor, and research and social service.

Our special group on rehabilitation would like to compliment the Governor and his staff for making such a conference available. We particularly want to compliment Dr. Lieben and his committee for the organization of the conference and the array of talent gathered together.

REPORT OF THE CHAIRMAN

John Curtin, Jr., Deputy Secretary
Department of Labor and Industry

Part I

The first speaker, Edwin M. Kosik, Esquire, Chairman, Pennsylvania Workmen's Compensation Board, addressed himself on the subject, "The Pennsylvania Occupational Disease Act and How It Works".

It was established that of the Pneumoconiosis family of diseases only silicosis and anthraco-silicosis are defined as occupational diseases under the law. All others, if to be established as occupational diseases, would have to be proved under a "catch all" provision provided in the statute.

Only total disability is compensable in the case of silicosis and anthraco-silicosis. In addition to exposure to the disease and certain requirements as to a proper application for benefits, a claimant who was totally disabled must establish, (1) A causal connection between the disease and exposure, (2) That the disease is peculiar to the occupation or industry, and (3) That it was not common to the general population. The statute provides for a rebuttable presumption that the disease arose out of and in the course of employment, if it is shown that immediately before disability an employee was employed in an occupation or industry where the disease is a hazard. In the case of the mining industry, the Courts take judicial notice that it is an industry in which the hazard generally exists. Usually, there is no need to establish the presumption in a mining industry case.

The "catch all" provision of the Act will apply to other pulmonary diseases not enumerated in the Act. Unlike the case of silicosis or anthraco-silicosis, it is possible to receive partial as well as total disability under the "catch all" provision. In fact the "catch all" provision is not limited to pulmonary occupational diseases, but applies to all occupational diseases not specifically enumerated under the Act, and which can be established to be occupational diseases. Here too, however, there are the similar requirements as to causal connection, peculiarity to the occupation or industry, and the requirement that the disease is not common to the general population.

Up until 1953, if a disease was found to be disabling as a result of an exposure for over a period of five years, the Commonwealth obligated itself to pay forty percent of the scheduled award, while the employer paid sixty percent. In 1953, the Act was amended to put the entire liability on the Commonwealth if it could not be conclusively established that the disability arose as a result of the employee's last exposure. The result has been to place the entire liability on the Commonwealth in most cases of multiple employment in a hazardous occupation.

Part II

William C. Diosegy, Comptroller, Department of Labor and Industry, addressed himself to the subject, "The Cost of the Occupational Disease Act". The cost factor referred to the liability of the Commonwealth over a period of years. It was established that the Commonwealth's contribution to occupational disease cases has grown from $425,000.00 in 1942 to a projected $21,000,000.00 for fiscal 1966. Significant in this cost rise was the amendment of 1953 wherein the entire obligation for compensation was assumed by the Commonwealth in cases of multiple employment. Subsequent to the amendment in 1953, the Commonwealth's contribution has steadily risen from one-half million to two – five – eight and finally the aforesaid projected 21 million dollars.

Part III

The next subject presented was entitled, "The Impact on the Economy of the Commonwealth". Mr. Arnold Smorto, Esquire, Counsel for the United Mine Workers of America, made the presentation. Mr. Smorto reminded of the contributions of the coal industry to the industrial might of the Commonwealth; the fact that mining was a basic industry in the nation and still remains a basic industry in this Commonwealth. He pointed out that the industry and its mining employees have constantly withstood economic fluctuations without subsidy. He later conceded that in 1953 the legislature granted what might be considered a subsidy when it placed the full burden of benefit payments on the Commonwealth in those cases where multiple employment was involved.

It was stated that the government was obligated to protect the industry, to encourage investors, as well as potential investors. Also, that the encouragement must be extended to labor to help provide the high quality of employee required in mining.

Next, Mr. Smorto warned against restrictive changes in the statute. He advocated an extension of benefits. He proposed that existing Statutes of Limitations be eliminated; that the Act be amended to provide for partial disability in cases of miners' asthma, and that a general provision be included to cover pneumoconiosis as a disease. In the case of mining, it was suggested that the legislature statutorily establish that mining is presumed to be a hazard.

The speaker admonished against statutory changes which would be dictated by a cost factor. He believed that a viable economy could support the present liberalization even though it seems costly at the moment. He suggests that claims have reached their crest. It was pointed out that in 1948 there were 110,000 miners in the soft coal industry and 80,000 in the anthracite industry. However, in 1963 the number has been reduced to 26,000 in the soft coal and 16,000 in the anthracite industries. As further evidence of a reduction in claims for occupational disease, he cited his own District No. 2 as an example. There was a drop of 50% in the number of cases filed in 1964 over the year 1963.

Part IV

The final subject of this session was entitled, "The Four-Year Statute of Limitations". Presentations were offered by Thomas B. Noonan, Esquire, Counsel for the United Mine Workers of America, and George W. Katter, M.D., Chief of Medicine, Mercy Hospital, Johnstown, Pennsylvania.

Mr. Noonan pointed to the history of the limitation period in which a claimant must become totally disabled following his last exposure to the hazard of the disease. If the disability or death does not occur in this period, (now four years after exposure), the claimant is barred from benefits. The reasons for the limitation are found in medical reasoning over a period of years that the disease, if to be disabling, would manifest itself within a stated period. Another reason for the period was that attributable to all Statutes of Limitation; i.e., that there must be a cut off point on all litigation.

Mr. Noonan commented on the most recent medical thinking that the disease being a progressive one, could manifest itself as a disabling factor at any time; ergo, the limitation period of four years no longer has any basis in medical reasoning. He suggests that if we are to be guided by humanitarian considerations alone, the Statute of Limitations should be eliminated. If we must be influenced by cost and economic realities, then the Statute of Limitations should at least be extended to ten or twelve years.

Dr. Katter discussed the limitation provision from the medical point of view. He has experienced many cases of total disability going uncompensated because of the limitation period.

He suggests that too often men with some disability leave the mines for other employment. In some cases the men must leave for other employment. The market for the services of these men is limited. Where employment exists, it is often denied to them because of their condition. In these cases, the disability very often does not manifest itself until beyond the four-year limitation period. Having been precluded benefits, they become wards of the State through public assistance.

Dr. Katter concluded in suggesting that all periods of limitations be eliminated; that an impartial board of physicians and attorneys be established to determine whether or not a case is compensable, and that "political" appointees and the adversary proceedings which now exist be eliminated. He further advocates mandatory periodic health examinations of employees in the hazardous industries.

Impressions

Of course, there are those who favor and those who oppose the many matters presented and discussed at this Special Session on Legislation.

The Session provided an opportunity for facts and opinions to be presented which amounted to an objective appraisal of the Occupational Disease Act as it exists today.

In conclusion, it is suggested that the individual as well as collective appraisals and opinions be made known to the proper authorities.